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Unusual Foundation Excavation Procedure for Los Angeles Garage

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Housecleaning at Home

IN passing on the famous Herminghaus case that came to it from California, the United States Supreme Court made no finding on the facts of the case but merely declared that it has no jurisdiction and dismissed the appeal. Thus, it sends the case back to California, where it previously went through the courts to final adjudication. For the present, then, California must continue to be hampered by an anomalous and obstructive dogma of the sanctity of floods, which will take time and education to correct. This is California's own job; it must do its own housecleaning. The decision of the federal high court plainly says that the state's own citizens must deal with an evil which they alone created and from which they alone suffer.

Let the Government Pay!

THE flood control committee of the United States Chamber of Commerce proposes that the federal government bear all the cost of both construction and maintenance of all structures built for the control of flood waters of the Mississippi River. Coming from a committee of an organization supposed to be made up of hard-headed business men grouped together to advance the economic welfare of the country, this is a startling proposal. It flies in the face of all sound economics. Few people will not admit that the federal government should bear a considerable portion of the cost of controlling floods of the magnitude of those which occur in the Mississippi Valley—because of the difficulty of distributing the cost equitably among those benefited. But to propose that the federal government bear all the cost, not only of building such works but of maintaining them, is to propose something which cannot be justified by any rational consideration. If the wealth-producing possibilities of the lands to be protected from overflow are less than the cost of protecting them, then they are not worth protecting. But if they produce more than it costs to protect them, then those who profit therefrom should bear at least a part of the cost of building and maintaining the flood protection works.

Setting a Bad Example

A STATE that attempts to control pollution of the air and injury to buildings and human life in the form of belching gases and black smoke from the stacks and chimneys of large buildings and industrial plants might be expected to do the same as to its own public buildings. A bad example to the contrary has been set of late at the Massachusetts state house, the power plant of which has been a gross offender. Criticism of this condition by city and district officials and by citizens has led the governor to promise that reform measures will be introduced. Those in charge of smoke prevention in the Boston metropolitan district were confronted by the fact that while they could sue private offenders they could not sue a sovereign state. This condition makes it all the more uregent for the state to set a good rather than a bad example.

Stable Prosperity

AMID the constant back and forth of discussion as to how long the present era of American prosperity is to endure it is refreshing to hear a forceful and convincing statement of optimism. This prosperity is created by causes deeply ingrained in our present industrial system, and therefore promises to be long continued, E. J. Mehren declared in an address last week before the Chicago Association of Commerce. We are prosperous, first, because our productive efficiency is high; second, because the man-power released by the growth of productivity is readily absorbed by new industries (such as the automobile and radio industries) which are possible only by virtue of the marvelous receptivity of the American market; and, third, because this receptivity is maintained on the one hand by high rates of pay in both the labor and the white-collar classes, and on the other by active research to develop higher efficiency, new kinds of production, and greater receptivity of the market. These words touch on some of the most intricate and far-reaching relationships of the world's economic system, and as they apply to the interest of every one of us, each man in this industrial era owes it to himself to give them searching scrutiny. Their logic is eminently sound. Such other factors as enter the case, psychological and material, appear to be of little influence for the time being.

Danger at the Bridge

IT has come to be a regular Monday morning practice of most newspapers to print a list of Sunday motoring casualties. Like the white crosses which the Ohio authorities erect by the roadside at the point of a road fatality, these accounts give a cumulative picture of special highway hazards. In this way they supply a frequent reminder of the special hazard that exists at bridges—that continues to exist in spite of its having been known and discussed and rediscussed for years. The bridge hazard has more than one element, among them roadway width, visibility, and ease of transition, but the matter of railings is probably as critical as any. The function of the bridge is to carry traffic across an opening, and in serving this function the railing is next in importance to the floor itself; both must hold traffic safely to its course across the opening. In this sense, however, most railings are little more effective than a white string stretched along the side of the bridge; they merely mark out a line of danger, but fail altogether as fenders that would be capable of holding a vehicle to the roadway even when it goes out of control. All but

a small fraction of the bridges on our highway system have railings that are such in name only. Until these are replaced by adequate construction, bridges will continue to represent special road hazards, and will continue to figure in the Monday morning casualty lists.

Ornamental but Obstructive

THAT sidewalk obstructions in city streets should be as few and as small as possible, for minimum interference with congested traffic and crowd movements, has been pointed out in various reports on city traffic improvement. But in spite of the obvious importance of this factor in pedestrian traffic congestion, many municipal authorities persist in erecting or demanding ornamental lamp posts which encroach seriously on the space of sidewalks which already are none too wide for the accommodation of even everyday traffic. As a rule, the objectionable feature of these posts consists in a broad and flaring base, which becomes still more objectionable from the fact that in order to keep the base within the curb line the post itself must be set further back than otherwise would be necessary. The ostensible purpose of the design, of course, is to give the appearance of a well-supported post seated on the sidewalk. As a matter of fact, the ornamental base provides no support, being merely the cloak for a substantial pipe post set in a good foundation below the sidewalk level. If the post itself is considered unsightly it may well be encased in a shell of more attractive appearance, but this shell need be little larger than the post and there is no reason why it should include a sham support which is so large as to constitute a permanent obstruction to traffic. Mere ornament which serves no useful purpose, but is actually detrimental, is a liability rather than an asset in general, and in city streets in particular.

Reservoir Leakage

FAILURE of a reservoir to hold water is a major disease, and one which it is the engineer's primary duty to forestall. But actual cases of leaky reservoirs suggest that either the subject has not always received its merited attention, or, perhaps, it sometimes overtaxes engineering skill. The indications are that the trouble is insufficient study of conditions, more often than lack of skill in dealing with them. The fact is that porosity of reservoir bottoms is a matter in which the engineer needs the help of the geologist, quite as much as in getting proper assurance of a satisfactory dam foundation; and, while in the latter problem geologists are very commonly called in, they are less often asked to consider the nature of the bottom of the proposed reservoir. The latter problem is simpler, and it may be that this is why the geologist is not so commonly called into consultation. The problems of concentrated weight and pressure with attendant danger of leakage and slippage do not enter, and because of the long path of flow of any leakage water, the danger of any small fissure or pervious contact or other local flaw is apparently minor. When this view is taken, however, there is danger that the influence of extensive earth or rock deposits may be undervalued. Badly seamed or cavernous rock, gravel deposits in the form of old stream beds or glacial moraines—sometimes partly concealed by cover—are among the trouble-making possibilities. It is safest to explore these possibilities fully by advance geological study, supplemented, where necessary, by test wells to determine underground flow. These studies will also indicate what can be done in the way of sealing the bottom by a blanket of clay or similar protection. When sealing has to be done after the reservoir project is completed, it means costly delay and less satisfactory results—again as amply shown by past experience. Altogether the subject is one requiring close contact between the engineer and the geologist. An engineering training supplemented by a comprehensive and well grounded knowledge of geology, which would give the engineering and geological view jointly, would perhaps be the best equipment. Every power and irrigation company would find such a man valuable. But an effective combination of the two sciences in one individual is rare. In general, co-operation of engineer and geologist is the essential reliance.

Throttling Railroad Construction

HOW far may the Interstate Commerce Commission go in restricting new railroad construction? What constitutes "convenience and necessity" under those provisions of the Transportation Act which place absolute control over new railway construction in the hands of the commission? These questions have been brought to the fore again by a recommendation of one of the commission's examiners that the application of the Piedmont & Northern Ry. for authority to build certain extensions in the Carolinas be denied.

The Piedmont & Northern Railway Co. proposes to build a link to connect its present line in South Carolina with its line in North Carolina and to extend the latter line some 72 miles northward to Winston-Salem. The present and projected lines of the Piedmont & Northern run roughly parallel to the Southern Ry. for the greater part of their length. Construction of the new portions is being actively opposed by the latter road as well as the Seaboard Air Line. Construction is favored, on the other hand, by local communities and state officials.

The Piedmont & Northern differs somewhat from the ordinary railroad. It is an electric line built by the late J. B. Duke to help serve industries attracted to the Piedmont section of the Carolinas by the cheap power developed by another of his interests, the Southern Power Co. Control of the line is closely held, largely by the Duke interests, and the owners propose to build the extensions with their own funds, thereby guaranteeing that the extensions are not to be used as the basis of a stock-selling scheme in which the public will hold the bag.

Those who oppose any further extension of the Piedmont & Northern Ry. claim that existing railroads can and do serve the territories adequately, and that the extension of the railroad would make serious inroads into the income of existing railways. Those who favor the line claim that because it uses electric traction it is better able to serve industries located on sites which are not accessible to steam operated railways; that the prosperity of the present short sections of the P. & N. is a fair measure of its necessity to the region; and that all the railroads benefit indirectly by the industries which it attracts to the region. Also that by entering into further competition with the Southern Ry. through the construction of new extensions it will force that road to improve its service in other regions as it has done in the territory served by the present P. & N. lines.

Between these conflicting claims the Interstate Commerce Commission must decide. We have little doubt of

the outcome, despite the adverse report of the commission's examiner. His finding that the territory is well served by existing railways is not a sufficient reason for rejection, because power over railroad construction was given to the commission for the express purpose not only of preventing unfair or cut-throat construction but also of stimulating competitive building wherever it is fair and useful.

Consequently, as we see it, the points upon which the commission must base its decision are: Whether the territory will be better served through the construction of additional railway lines, without too much sacrifice upon the part of existing railways; and whether there are adequate indications that traffic to and from the territory is increasing. If these questions are answered in the affirmative then both the requirements of convenience and necessity are fulfilled and the commission has no alternative but to permit construction to proceed.

Remote Control Possibilities

SMALL hydro-electric plants that are entirely automatic or at least subject to remote control are not unusual and have long been considered good practice as an operating economy, particularly as an adjunct to a plant whose operators are continuously in attendance. In recent years there has been more extended use of these automatic plants, and they have been built in larger sizes. Perhaps the development of highly dependable automatic control devices for automatic substations on power distribution systems has had something to do with this, or it may be that increased confidence has resulted from wider use of automatic equipment of this sort; perhaps both. At any rate, automatic generating stations of large size are coming into vogue and bid fair to be an important factor in future hydro-electric practice.

In the Glines Canyon plant in the state of Washington, a 20,000-hp. hydro-electric unit with all its attendant mechanism for regulation and control operates continuously day and night with no direct attendance other than such as can be given in a powerhouse seven miles away. This plant, like others of its type, is designed to require an operator only to check the oil supply, make adjustments in the equipment, or correct some derangement. Because the control mechanisms of such plants appear intricate it might be assumed that they introduce a considerable risk of derangement. However, the automatic starting and stopping of the unit is not at all complex and, in the main, goes through the same processes as are required when an operator is in charge. Moreover, most of these processes are accomplished by electrical devices which have been used in other service so long that they have been developed to a point where they are highly dependable. Aside from the normal operations of starting, bringing up to speed, synchronizing and cutting into the main system, an automatic generating station is equipped to forestall damage from dangerous operating conditions that may arise. These safeguards, really more alert than a human operator could possibly be, stand in readiness to close down the unit whenever danger threatens. A shutdown for one of the causes that might mean a serious or lasting derangement is effected in such a way that the unit cannot be started by remote control until an operator has visited the plant, rectified the trouble, and reset a safety lock.

A 15,000-hp. automatic generating unit is now being installed in the Alouette plant of the British Columbia Electric Co., and a much larger plant in which several large units will be operated by remote control is also under construction.

Success in the application of remote control to these larger plants will insure the more immediate development of not a few power sites, heretofore considered to be just outside the limits of economic development, for it happens frequently that the cost of maintaining an operating staff at an isolated plant tips the balance the wrong way when weighing all the items of cost in preliminary studies of a water-power site.

Mistreated Equipment

NEGLECT of contractors' equipment when not in service and rough treatment in shifting are still often observed, in spite of frequent explanation of the economy of taking proper care of plant which represents financial investment and the means of carrying on the owner's business. And this observation is true not only of the smaller and less experienced firms; some larger firms of such experience that they might be expected to have a proper conception of the economic aspect of plant management are astonishingly neglectful.

In watching recently the installation of equipment for pile and concrete work, the first impression was that the contractor was unloading discarded material to go to the junk dealer. Everything was crusted thickly with dirt and rust, the discharge openings of concrete mixers were dented out of shape, and the bright or wearing parts of machinery, that should have been greased or whiteleaded when in storage, were rusty and dirty from neglect.

Closer examination indicated that the equipment probably was fairly good and would operate efficiently after having got into working condition. It seemed likely, however, that the machinery would have to get into this condition largely on its own account; that is to say, it would be run in some sort of way until the rust was worn off, the bright parts would be given a little oiling or cleaning by the operator, and the whole plant finally "broken in" by its service operation. Meanwhile poor work, slow work and much human and machine friction would result in the unavoidable breaking-in process.

Adding insult to injury, as it were, in unloading the equipment, to be assembled in place later, it was dumped almost at haphazard, with little regard for possible racking or distortion. Hoists were landed on rough ground and held up by a few stones or pieces of rotten timber put under the frames; steam pile-hammers were landed on piles of riprap, and pile-driver derricks were laid flat in such a way as to have very uneven supports. With rough handling, the ladder on one derrick was badly damaged and it is an even guess that the broken parts will not be repaired properly (if at all) when pile-driving begins. All this was done under the eyes of a superintendent.

We believe that this extreme neglect is uncommon, but the query arises why such practices should ever exist. Besides the deterioration losses on the equipment itself it is certain that an inspector or resident engineer observing such slovenly practices could hardly help being prejudiced in advance and feeling that he would have to watch closely to prevent poor work.

New Design Features in Willwood Diversion Dam

Canal Headworks Incorporated in Structure of Dam—Apron Shaped to Localize Jump Near Overfall—Foundation Grouting—Uplift Pressures Measured

By Ivan E. Houk
Research Engineer, U. S. Bureau of Reclamation, Denver, Colo.

SEVERAL interesting features were involved in the design and construction of the Willwood diversion dam on the Shoshone irrigation project of northern Wyoming. For instance, the canal headworks were made an integral part of the dam, the diversion water being carried through a longitudinal tunnel within the structure; the fore apron was designed to keep the hydraulic jump close to the downstream face of the ogee weir; the tightness of the foundation was tested by applying hydraulic pressure to the grout holes before grouting; periodic measurements of uplift pressure were made as soon as the closure of the structure was effected; and accurate records of cost were maintained throughout.

The dam is located on the Shoshone River about 10 miles southwest of Powell and about 24 miles below the Shoshone reservoir. It was built by the Bureau of Reclamation, by force account, in 1922 and 1923, as a part of the development of the Willwood division of the Shoshone project. Briefly speaking, it is a concrete gravity, overflow structure surmounted by a 3-span riveted steel truss highway bridge; a headworks section 49 ft. long is constructed at one end. The total length of the structure between abutments is 320 ft. The overflow section, which was designed to discharge 25,000 sec.-ft. with a depth of 9 ft. on the crest, is 271 ft. long and approximately 55 ft. high above the foundation, while the headworks section is approximately 70 ft. above the foundation. Fig. 1 gives the general details of design while Fig. 2 is a view of the dam from a point downstream taken during a flood which occurred just before the bridge was completed.

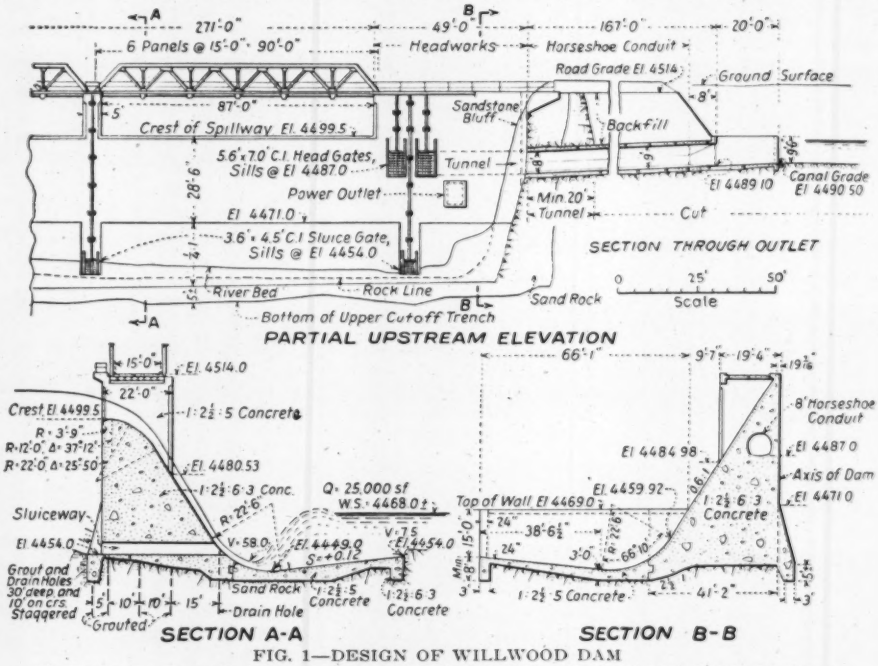


FIG. 1—DESIGN OF WILLWOOD DAM
Diversion tunnel carried longitudinally through structure. Apron shaped to localize jump.

General Design—Location, type of design, and height of structure were determined from comparative study of many alternative locations, carried on during a number of years. The adopted height of structure depended primarily on the location of the main canal; because of the shifting river channel any type of canal or conduit built along the cliffs of the river canyon was considered less desirable than a canal located on the high bench lands back of the canyon. The decision to adopt a gravity section rather than a hollow type of dam construction was essentially the result of existing foundation conditions. On the horizontally stratified and seamy shale and sandstone bedrock, a hollow overflow dam, adequately designed for such a foundation, would have cost practically as much as a gravity dam.

The gravity sections were designed to resist the horizontal water thrust under the maximum head and also an uplift pressure over one-half the area of the base varying uniformly from full reservoir head at the upstream side to full tail-water head at the toe. This is equivalent to assuming uplift pressures over the entire area of the base, varying from one-half of full reservoir pressure at the upstream side to one-half of tail-water pressure at the downstream side. The limiting coefficient of sliding was taken at 0.65 and the final analysis of the loads showed values of 0.65 for the spillway section and 0.63 for the headworks section, neglecting the effect of shear in the cutoff walls. On account of the comparatively low height of the dam foundation pressures were of minor importance, the maximum at the toe amounting to only about 3 tons per sq.ft. The resultant of the total forces pierces the base well within the middle third under all conditions of loading, in both spillway and headworks sections.

In order to control the sand and silt accumulations at the upstream face of the dam, as well as to provide a means of draining the pond, three rectangular sluiceways 3.6x5.4 ft. in size were installed just above the

river bed. These openings run transversely through the dam, from upstream face to downstream face, with inverts level and at El. 4454.0. One was located in the headworks structure, as shown in Fig. 1; the other two were placed vertically under the two bridge piers. Each sluiceway is controlled by a 3.6x4.5-ft. cast-iron slide gate, operated from the bridge floor above. The outlet

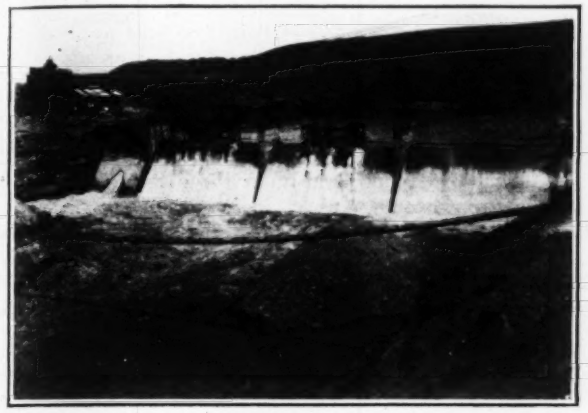


FIG. 2—UPSTREAM VIEW OF WILLWOOD DAM
Mixing plant at left. Hydraulic jump held close to dam by depressed apron.

end of the headworks sluiceway may be seen in Fig. 6. An additional outlet 5.6x7 ft., for use in a contemplated future power development, is provided at the north end of the dam.

As a protection against underflow and undermining, cutoff walls were built at the upstream face of the dam and the downstream face of the fore apron. Transverse contraction joints were provided in the ogee section at intervals of approximately 30 ft. along the dam. These were fitted with keyways, 24 in. wide and 12 in. deep, spaced about 6 ft. No leakage, through either horizontal or vertical joints, can be observed on the downstream face of the dam at times when the entire flow of the river is being diverted, in spite of the fact that no copper seals were inserted in any of the joints. The fore apron was built as a continuous slab without joints.

Diversion Headworks—Provision for diverting 320 sec.-ft. of water into the Willwood main canal, to supply an irrigable area of 17,000 acres, was made at the north end of the dam, as shown in Fig. 1. Water is taken from the upstream side of the dam into an 8-ft. horseshoe tunnel which passes longitudinally through the structure to the north abutment. From the north abutment the tunnel passes into the hillside, where it connects with a 9-ft. horseshoe tunnel, the latter section entering the main canal 167 ft. from the end of the dam. Flow into the tunnel is controlled by two 5.6x7-ft. cast-iron headgates with sills 35 ft. above the river bed. The transition from the sluicegate passageways to the horseshoe section (Fig. 3) is located wholly within the headworks structure.

An 8-in. concrete lining was placed in the tunnel from the edge of the abutment to the junction with the canal. This was reinforced as a protection against possible ground swelling in the shale sections and water pressure from the pond above the diversion works. Reinforcement consisted of $\frac{3}{8}$-in. and $\frac{5}{8}$-in. square bars on 12-in. centers, the larger bars being used in the section where an open shaft had been excavated and used as a site for the mixing plant. After the dam was completed and water had passed over the crest for several months a number of small leaks appeared in the tunnel lining, some of the leaks being accompanied later by a deposition of salts on the inner surface of the tunnel. In order to prevent serious disintegration of the concrete, holes were drilled into the lining at these places and the concrete thoroughly impregnated with grout.

Fore Apron—The fore apron was designed to keep the hydraulic jump close to the downstream face of the dam so that the energy of the water would be dissipated before it reached the natural channel. This avoided the necessity of placing riprap on the stream bed below the apron, a precaution which otherwise would have been required in order to prevent erosion of the sandstone and shale materials. The desired upstream location of the jump was obtained by depressing the surface of the apron 5 ft. below stream bed at the face of the dam, then raising the surface on a smooth curve to the level

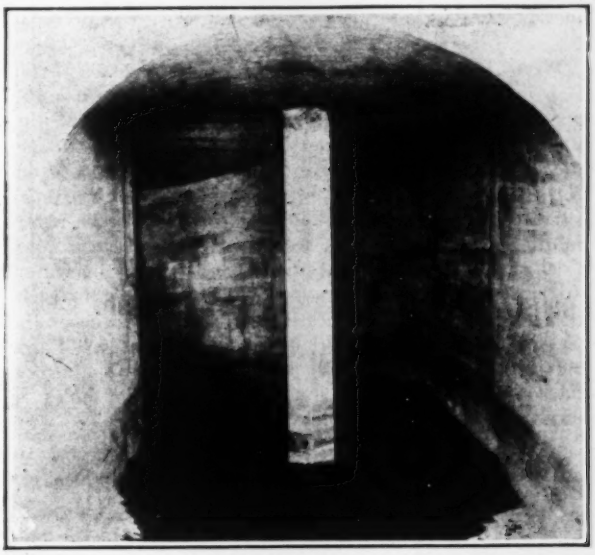


FIG. 3—TRANSITION FROM INTAKE TO TUNNEL
This transition is located wholly within the dam.

of the stream bed at the downstream edge of the apron. Fig. 2 shows that the disturbances in flow are being confined to the area over the apron, as planned. No appreciable erosion of the bedrock has occurred.

The idea of depressing the surface of the apron near the face of the dam so as to obtain an upstream location of the hydraulic jump was suggested by J. L. Savage,

TABLE I—UPLIFT PRESSURES AT WILLWOOD DAM

Line	Pipe	*Head on Base in feet, on dates noted— May 2, '23	May 9	May 17	May 31	June 1	June 7	June 11	June 16	July 6	Sept. 29	July 1946
1	A	12.7	....	11.2	29.7	31.0	31.6	31.0	33.2	33.4	16.6	29.6
	B	9.9	....	2.3	9.0	3.0	3.8	4.2	4.9	7.8	9.6	12.6
	C	8.8	....	11.7	3.5	11.5	14.8	14.6	15.4	17.3	10.1	12.2
	D	12.0	....	10.2	12.3	11.8	12.0	11.0	13.1	14.2	11.3	12.6
2	A	12.1	11.1	12.5	11.8	11.5	11.6	11.6	11.7	12.1	11.7	....
	B	7.7	1.1	—½	−1.2	−1.5	−1.3	−1.6	−1.0	−1.0	0.0	−0.5
	C	....	10.6	12.8	17.0	16.2	16.5	16.2	17.0	18.6	14.7	12.2
	D	12.4	8.8	11.9	14.0	15.8	18.9	15.7	16.9	17.6	15.0	10.6
3	A	13.1	12.5	15.7	18.2	21.9	22.8	28.0	25.7	28.0	22.3	15.3
	B	11.5	....	16.0	18.7	18.0	18.1	18.3	18.5	19.6	10.8	14.6
	D	11.0	10.0	11.7	14.6	15.1	15.3	17.8	15.9	17.5	9.8	10.4
Depth above dam		18.3	22.0	25.2	40.7	44.7	45.4	42.6	50.2	50.4	33.3	51.7
Depth of tailwater		9.3	9.4	9.5	10.1	10.1	10.1	11.0	11.0	11.5	8.5	11.0

* Elevation of base 4451.

chief designing engineer, in 1921. The occurrence and location of the jump were determined by calculation, using the hydraulic jump formulas and estimating friction losses on the basis of Kutter's n = 0.012. It was found that the depression of 5 ft. would be sufficient to

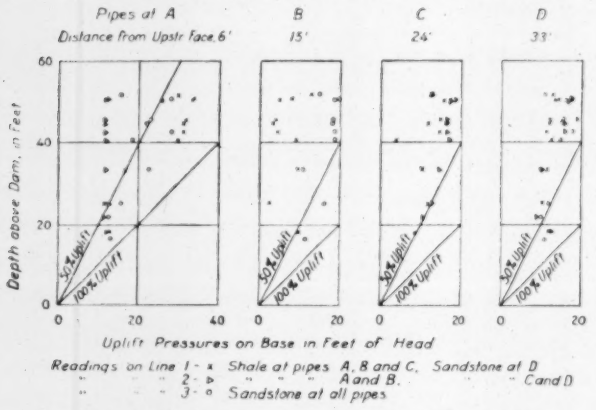

Pipes at A B C D
Distance from Upstr Face 6' 15' 24' 33'
Depth above Dam, in Feet
50% Uplift
100% Uplift
Uplift Pressures on Base in Feet of Head
Readings on Line 1 - x Shale at pipes A, B and C, Sandstone at D
2 - b A and B. C and D
3 - o Sandstone at all pipes

FIG. 4—MEASURED UPLIFT PRESSURES UNDER WILLWOOD DAM

cause the occurrence of the jump under full-load conditions, whereas a depression of 4 ft. would not be sufficient.

The fore apron extends 54 ft. downstream from the toe of the dam and terminates in a cutoff wall having a minimum depth of 8 ft. It was reinforced with $\frac{5}{8}$-in. square bars on 16-in. centers, laid in both directions, as a precaution against possible damage due to undermining or uplift pressure.

Foundation Tests, Grouting, and Draining—On account of the soft and seamy nature of the foundation, four lines of grout holes and one line of drain holes were located and drilled (Fig. 1). In addition, 16 lines of grout holes were drilled in the abutments. After the grout holes were drilled it was decided to test the tightness of the rock by subjecting some of the holes to water pressure from the mixer tank, about 80 ft. above, a head of 10 to 15 ft. more than would exist after the dam was completed. Twenty-one representative holes were selected, some in sandstone and some in shale. Simultaneous observations were made in adjacent holes to detect any possible subterranean passage of the water. In some cases it was necessary to cap adjacent holes in order to obtain a representative test. In other cases the holes would take but small quantities of water. Three holes took no water at all. Holes located in shale took relatively small amounts, while some of the holes in sandstone took as much as 28 gal. per min.

TABLE II—UNIT COST OF DRILLING AND GROUTING FOUNDATION AND ABUTMENTS OF WILLWOOD DAM

Class of Work	Cost per Foot	
Drilling, labor	$0.30	
Drilling, power, fuel, and lubricants	0.08	
Drilling, miscellaneous supplies	0.22	0.60
Operating machine, labor	0.39	
Operating machine, power, fuel, and lubricants	0.16	
Operating machine, cement and sand	0.47	1.02
Miscellaneous	0.10	0.10
Plant and equipment	0.48	0.48
Total cost per lineal foot	$2.10	$2.10

146 holes, 4,185 lineal feet, 2,062 sacks cement, 347 sacks sand.

After a substantial layer of concrete had been placed (at least 3 ft. and usually 10 or 15 ft. in thickness), the holes were thoroughly grouted, using a pressure of 100 lb. per sq.in. The general proportion of grout was a sack of cement to 60 gal. of water, but the mix was varied and sand was included at times. If this proportion was taken freely, it was thickened gradually until the hole would take no more. Then a thin mix was again tried. Some strange situations developed. One hole that would take no water took 537 sacks of cement and 181 sacks of sand. Other holes which took water would take no grout. Passage from one hole to another was erratic and sometimes required capping of adjacent holes, thus indicating that a smaller number of holes would have been sufficient.

The grouting machine was connected first to one hole, then to the next, and so on, the grouting operations being carried on continuously in three 8-hr. shifts so that the grout would not set in adjacent holes before they could be grouted.

Two-inch pipes were inserted in the drain holes and brought up vertically through the concrete to the face of the dam. This provided a means by which the holes can be tested and cleaned if necessary. Horizontal drainage outlets to the downstream face were provided at a suitable elevation.

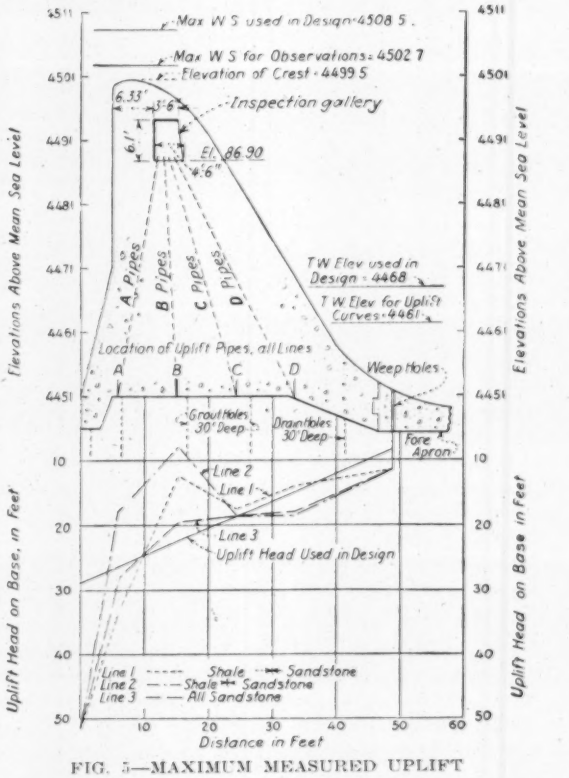


FIG. 5—MAXIMUM MEASURED UPLIFT

Uplift Pressure Measurements—Twelve $1\frac{1}{2}$-in. pipes, for measuring uplift pressures on the base of dam, were installed under the south bridge pier near the line of contact between the shale and sandstone formations. The pipes were arranged in three lines of four pipes each. Individual pipes were spaced about 9 ft. apart and the lines approximately 7 ft. apart. Lines 1 and 2 were located partly on shale and partly on sandstone, the shale being on the upstream side of the dividing line; line 3 was located entirely on sandstone. Straight pipes were run from the surface of the bedrock foundation through the concrete to an inspection gallery $4\frac{1}{2}$x6 ft.,

34 ft. long, the cross-section of which is shown in Fig. 5, where the uplift observations were made by sounding. Special precautions were taken to be sure that the lower ends of the pipes were open and in contact with bedrock, and all holes were pumped out a few days before each series of readings was started, to eliminate any possible effect of changes in stage which had occurred some time earlier.

TABLE III—UNIT COST OF CONCRETE CONSTRUCTION AT WILLWOOD DAM

Location of concrete	Dam	Dam	Apron
Plain or reinforced	Plain	Reinforced	Reinforced
Proportions	1:2½:6:3	1:2½ 6:3	1:2½:5
Quantity in cubic yards	16,648	213	3,173
Class of Work	Unit Cost Per Cubic Yard		
Preparing foundation	$0.22	$0.30	$0.65
Cement	3.25	3.47	3.98
Sand and gravel	1.13	0.70	1.50
Heating	0.37	0.47	0.24
Mixing	0.21		0.39
Transporting and placing	0.43	1.03	0.77
Forms	0.73	1.03	1.25
Reinforcing		0.79	0.79
Placing			0.41
Unwatering site	0.09	0.49	0.28
Finishing, sprinkling, protecting	0.10	....	0.36
Miscellaneous expense	0.27		0.38
Plant and equipment	1.62	2.90	3.10
Total cost per cubic yard	$8.42	$11.18	$14.10

Table I gives the uplift pressures in feet of head for all observations to date. Holes B on lines 1 and 2 are apparently watertight, since the greater number of readings are lower than the tailwater depth. Hole C on line 3 became plugged before any measurements could be obtained. Fig. 4 is a graphical representation of the data, uplift pressures in feet of head being platted as abscissas against depths above the dam as ordinates. Readings at the B pipe on line 2 are not shown, since the water levels were below the base of the dam. Diagonal lines are drawn to indicate uplift pressures equal to 50 and 100 per cent of the depths above the dam.

Fig. 4 shows that the observations are somewhat erratic, even when the headwater elevations are the same. This would naturally be expected in view of the foundation conditions. Probably some of the variation in uplift pressure, for the same upstream depth, is due to a tightening of the foundation accompanying the deposition of sand and silt above the structure. Tightening may also have occurred due to a deposition of salts within the minute passageways through which the water finds its way. The observations of July 1, 1926, seem to indicate that some tightening has taken place. As a general rule, uplift pressures seem to be lower in the shale area of the base than in the sandstone area, thus indicating that a more satisfactory grouting effect was obtained in the shale.

Fig. 5 shows the location of the pipes with reference to the cross-section of the dam, the location of the grout and drain holes, and the maximum uplift pressures observed to date, the last being platted beneath the cross-section in the usual manner. Curves representing observed uplift pressures have been arbitrarily extended as straight lines from the values observed at the A pipes to the maximum observed reservoir head at the upstream edge of the dam; also as straight lines from the values observed at the D pipes to the maximum observed tail water head at the downstream edge. The latter is probably an accurate assumption. The former may indicate uplift pressures greater than those actually existing due to the thorough grouting of the foundation. The full diagonal line at the bottom has been added to represent assumptions made in designing the structure, namely, that the uplift effect may be allowed for by assuming uplift pressures to act over the entire area of the base, varying in intensity from one-half of full reservoir head at the upstream side to one-half of tail water head at the downstream side. While readings have not been secured for head- and tailwater elevations as great as the maximum assumed for design purposes, the diagrams clearly show that the structure is safe and that the uplift assumptions were well chosen.

Construction Methods—The bulk of the excavation was handled by dragline, rock material being loosened by blasting. In order to avoid shattering of adjoining parts of the foundation, and because of the fact that the rock was not very hard, cutoff trench material was chipped out using points in the jack hammers, instead of by drilling and shooting. Grout and drain holes were drilled with tripod drills mounted on special deep-hole tripods using lengths of steel varying from 6 to 32 ft.; an average of 6.18 ft. was drilled per 8-hr. shift, sometimes as many as four 30-ft. holes being completed in one shift.

The sand and gravel plant was located on the north side of the river about 700 ft. from the dam, and the screening and mixing plant was placed in an open-cut section of the diversion tunnel a short distance from the north abutment. The mixer was placed under the aggregate bins, where it was fed by gravity, discharging directly into a hopper which fed the cableway bucket. The bucket was hoisted and carried on the cableway to the hopper and chute, where it was automatically tripped and dumped.

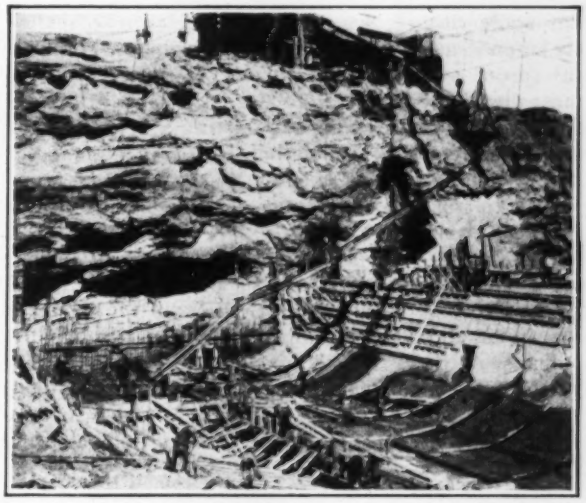


FIG. 6—CONCRETING AT NORTH END OF DAM
Dam and apron partly constructed. Diversion tunnel, hopper and chute may be seen.

In Fig. 6 are shown the concreting operations at the north end of the dam while the fore apron was being poured. It also shows the seamy nature of the sandstone cliff at the north side of the river. The cableway was 420 ft. long, and the chute sometimes as much as 95 ft. long, the greater lengths being used while concreting the outer parts of the fore apron. The mixer was a 1-yd. machine driven by a 40-hp. motor. Practically all equip-

ment on the work was driven by electric power from the Shoshone power plant.

There were comparatively few delays in the work due to breakdowns in the plant, or to lack of sand and gravel, but there were some delays due to extreme cold weather. Concreting operations were discontinued whenever the temperature was lower than 15 deg. F. Aggregates were heated and the concrete was kept warm after placing whenever there was any danger of freezing.

A great deal of care was taken to prevent subsequent leakage through the dam. No surfacing of concrete was permitted at the end of a day's work and no horizontal joints were allowed without keys. Before a new run was placed in concrete that had set, the entire surface was thoroughly cleaned, special care being taken to remove any laitance, and a generous supply of rich cement mortar was spread over the entire surface. A few batches of unusually rich concrete were then deposited before the placing of the regular mix was started. After the water was allowed to rise behind the dam it was found that there was no leakage except in a very few spots. Moreover, such small leaks as did develop stopped within a comparatively short time.

TABLE IV—MISCELLANEOUS UNIT COSTS OF WILLWOOD DAM CONSTRUCTION
Unit is cubic yard

Class of Work	Quantity Cu. Yd.	Unit Cost
Dry earth excavation	6,300	$0.47
Dry rock excavation	10,286	2.92
Tunnel excavation	841	4.10
Reinforced-concrete tunnel lining	277	20.90
Gates	41,000	0.17
Highway bridge, material	186,550	0.055
Highway bridge, placing, erecting, painting	186,550	0.022
Highway bridge, floor, lighting, miscellaneous	186,550	0.019
Highway bridge, plant and equipment	186,550	0.024
Sub-total for bridge		0.120

Unit Costs—Table II gives the unit cost of drilling and grouting the foundation and abutments, Table III the unit cost of concrete construction in the dam and fore apron, and Table IV miscellaneous unit costs. The total cost of the structure amounted to $337,000. The cost of camp maintenance was 5 per cent of the total; engineering and inspection was 3.7 per cent; superintendence and accounts 3 per cent and general expense 5.8 per cent.

On the average 180 men were employed when the work was in full progress. Carpenters were paid from $5 to $7 per day, laborers from $3.20 to $4.50, and other classes of labor accordingly. Board was provided at $1 per day, later increased to $1.20 per day. Labor was obtained mostly from the farms and towns of the project, but some help was brought from Billings, Mont., during the harvest and fall seasons. Excavation was started Aug. 17, 1922, the bridge was opened for traffic July 23, 1923, and miscellaneous work of all nature was completed by May, 1924.

Engineer R. B. Ward was in charge of the work, under the general supervision of Project Manager J. S. Longwell. The designs were prepared under the direction of J. L. Savage, chief designing engineer. All engineering and construction work of the Bureau of Reclamation is under the direction of R. F. Walter, chief engineer, with headquarters at Denver, Colo., and all activities of the Bureau are now under the general charge of Dr. Elwood Mead, commissioner, with headquarters at Washington.

Stream Pollution and Industrial Wastes in Wisconsin

ON THE basis of an extended survey of stream pollution by sewage and industrial wastes, and the relation of the latter to sewage treatment, some conclusions have been presented in a detailed report prepared by the bureau of sanitary engineering of the Wisconsin State Board of Health. This survey was authorized by the legislature in 1925, which appropriated $10,000 annually to enforce the statutes in regard to stream pollution. The State Board of Health and the Conservation Commission co-operate in expending this fund and the present joint report covers the activities from July 1, 1925, to Dec. 31, 1926. A summary of the conclusions follows.

Mississippi River Pollution—Above Minneapolis and St. Paul the river is in reasonably unpolluted condition and favorable to aquatic life. In the metropolitan area, gross pollution is caused by untreated sewage from a population of 400,000. The accumulation of sewage sludge behind the high dam creates offensive conditions during periods of low stream flow and high temperature of the water.

From the metropolitan area to Hastings, Minn., the dissolved oxygen is almost entirely depleted during the summer. From Hastings to Red Wing, where little additional pollution enters, there is some recovery due to natural purification and to oxygen furnished by tributaries, notably the St. Croix River; but conditions are still critical for fish and aquatic life during hot weather and low stream flow. From Red Wing through Lake Pepin to Winona, Minn., there is a marked recovery in the stream. The turbidity decreases, oxygen increases and conditions are fairly satisfactory for fish and aquatic life.

Immediate consideration should be given to treatment of sewage from the metropolitan area of the Twin Cities prior to its discharge into the Mississippi River.

Treatment of Various Industrial Wastes—Conclusions based upon experimental work and collection of data include:

1. PEA-CANNERIES: The application of 3¼ lb. of ferrous sulphate and 7½ lb. of lime per 1,000 gal. of pea-cannery waste, followed by satisfactory sedimentation, will reduce the oxygen demand of such waste approximately 75 per cent. The cost of necessary equipment for a cannery discharging a maximum of 100,000 gal. per day ranges from $2,000 to $2,800, and the operating cost from $13 to $15 per day. Experiments with chemical treatment show that removal of the coagulated solids from the cannery wastes is essential to prevent overloading of sewage-disposal plants during the canning season.

2. PAPER MILLS: Suitable save-all equipment will economically reduce the waste of paper-making material to about ½ lb. per 1,000 gal. of waste. Aerating and impounding sulphite liquor from sulphite mills will reduce the oxygen demand 50 to 75 per cent.

3. KNITTING MILLS: In the preliminary treatment of knitting-mill wastes, the lint and greasy constitutents, which interfere with the normal operation of sewage disposal plants, can be removed by fine mechanical screening and ferrous sulphate and lime treatment.

4. COMBINED SEWAGE AND WASTES: Experiments at Waupun, Wis., on city sewage combined with wastes from dye-works and pea and corn canneries indicated that either the activated-sludge process or preliminary sedimentation, chemical treatment and aeration would yield a satisfactory effluent. The combination of processes just named was recommended by the consulting engineer for the city; plans to that end have been approved by the state board of health and construction has been authorized by the city council of Waupun.

Timber Bulkhead Protects Levee In Louisiana

Mississippi River Levee at Arabi, La., Adjacent to Industrial Plants Raised 3 Ft. and Held by Fill Behind Bulkhead

TO PROVIDE adequate flood protection for extensive industrial and manufacturing plants at Arabi, La., it was necessary to raise the grade of the Mississippi River levee about 3 ft. This work was done in 1926. Enlargement could not be made on the land side without encroachment on these plants, while the river slope was at the edge of the water, so that any filling would have been washed away as fast as deposited. To meet this condition, a bulkhead wall of piles and sheeting was built on the river front, 60 ft. from the center line of the old levee, so that a solid fill could be placed behind it. This construction extends along the waterfront for a distance of about 2,500 ft.

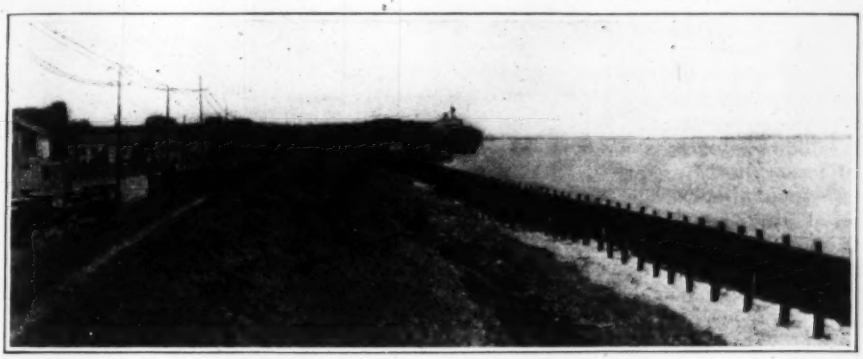


FIG. 1—NEW BULKHEAD FOR ENLARGING LEVEE
Grade of old levee, shown by footpath, raised 3 ft. by filling behind bulkhead.

For the bulkhead, Figs. 2 and 3, there are two rows of 30-ft. round piles, with a line of triple-lap interlocking wood sheeting secured between two lines of waling timbers behind the front row of piles. Through bolts in the top of the wall are attached tie-rods secured to the rear or anchor piles. Curved washers or collars, ½x4x6 in., are fitted between the nuts and the faces of the piles. A crawler crane, with drop-hammer leads suspended from the boom, did the piledriving. The piles and timbers are of southern pine, creosoted by the empty-cell process to give a net retention of 10 lb. per cubic foot. In construction, all cut surfaces were given three coats of hot creosote oil and a top coat of hot paving pitch. Filling material was delivered in barges and deposited by a floating dredge with a grab bucket.

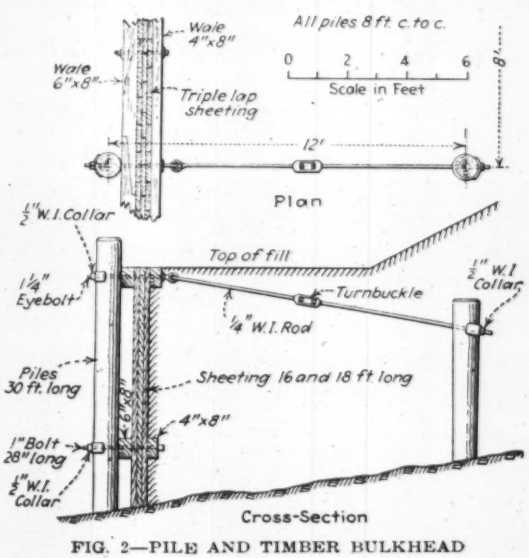


FIG. 2—PILE AND TIMBER BULKHEAD

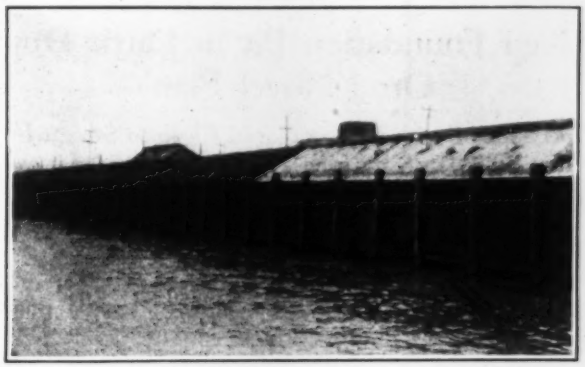


FIG. 3—BULKHEAD FORMS FACE OF LEVEE
Old levee shown here was raised 3 ft. by filling behind new bulkhead.

In Fig. 3, the new bulkhead is shown at low-water, with the old levee behind it. Fig. 1 shows the work ready for the filling.

The contractors were the Highway Construction Co. for the bulkhead and Scott & Brothers for filling. This protection work was built under the direction of the State Board of Engineers.

Czechoslovakia Creates Large Highway Fund

The National Assembly of Czechoslovakia recently passed a law creating a highway fund of $30,000,000 to be used over a period of ten years for the construction and maintenance of roads throughout the country, according to a statement from Frank P. S. Glassey, vice-consul at Prague, to the U. S. Department of Commerce. Another law provides for national taxation of motor vehicles which will go into the highway fund, as will receipts from import duties on mineral oils and automobile tires. To provide immediate liquid capital, the law authorizes all governmental insurance companies to turn over their profits, up to a total sum of $60,000,000, to the highway fund at regular intervals during the next ten years, this loan to be amortized, with 5½ per cent interest, in 69 semi-annual payments. The road fund is entrusted to the joint management of the Ministry of Public Works and the Ministry of Finance. In addition, a road council will consider the construction program.

Deep Foundation Pit in Earth Dug On a Novel Plan

Forty-foot Basement Excavated Close to Streets by Full-Depth Peripheral Trenches Braced to Interior Core

By Zara Witkin
Chief Engineer, Herbert M. Baruch Corp.,
Los Angeles, Calif.

A BASEMENT pit three full stories deep in earth has been completed close to busy streets in Los Angeles by a method which gave full-area power-shovel operation with braced banks. The work was done during a season of the heaviest rainfall recorded in years. The principle of the method used was the excavation of a deep trench by steam shovels on the outside boundaries of the lot, to the full depth of the exterior footings and the bracing of the exterior earth banks against the cores of earth left standing in the center of the site. When this trench was finished the exterior footings were poured, and the exterior wall built to grade. Then, with this complete protection, the interior earth core was removed, and the remainder of the foundation work completed.

The outside dimensions of the building, which is a garage, are 145 ft. on Hill St., 153 ft. on the Ninth St. front, 145 ft. on Blackstone Court (a 16-ft. alley parallel to Hill St.), and 153 ft. along an abutting automobile parking lot. Through the co-operation of the Board of Public Works it was made possible to provide for pedestrian walkways on the Hill St. frontage, approximately 16 ft. outside the building line, and on the Ninth St. frontage 10 ft. outside the building line. On the Blackstone Court frontage a width of 5 ft. was temporarily rented from the engineering department of the city, and on the automobile park side a strip of 8 ft. was rented. These additional clearances outside the actual property

FIG. 1—EXCAVATION FOR FOUR-STORY BASEMENT, LOS ANGELES, CALIF.

lines made it possible to use the methods adopted to provide effectively for entire safety against earth slip which, on these heavy traffic streets, jammed with pedestrians, automobiles, and street cars, would have been dangerous.

The first operation, Fig. 2, was the excavation by power shovel of a ramp beginning in the middle of the Hill St. frontage and proceeding east across the lot to an elevation of approximately 18 ft. below sidewalk level in the east boundary of the lot, cutting an inclined trench about 27 ft. wide. The grade of the bottom of this trench was approximately 13 per cent and the side-banks were sloped about 4 on 1.

When the east border of the lot was reached this shovel turned south and proceeded on the border of the lot, digging a trench approximately 30 ft. wide at the —18 ft. level. As soon as sufficient clearance was provided, another steam shovel descended the ramp and proceeded north on the east boundary at the —18 ft. level. Turning the corners at the south and north boundaries of the site, the shovels continued respectively to the west until they reached the west lot line. One shovel then retraced its path and left the job. The other shovel also returned

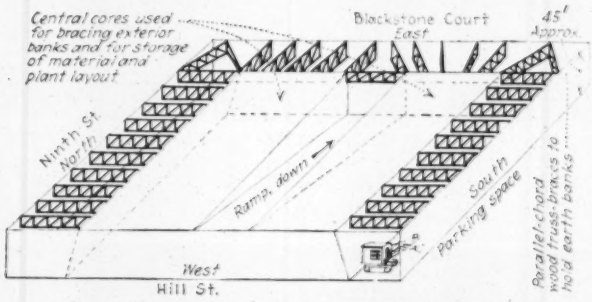


FIG. 2—DIAGRAM OF EXCAVATING METHOD OF FOUR-STORY BASEMENT

1. Cut dirt ramp in center of lot down to —18 ft. 2. Dig trench 30 ft. wide and 18 ft. deep all around borders of lot. 3. Dig new ramp down to —40 ft. 4. Dig new trench 30 ft. wide and 40 ft. deep around borders of lot. 5. Brace exterior banks against interior cores immediately behind steam shovel. 6. Place exterior footings and walls to grade. 7. Build wood ramp. 8. Remove interior dirt cores.

to the entrance point at Hill St. and commenced digging the rampway on a 30 per cent grade down to —40 ft. at the east border of the lot. Turning to the south at the low point of the ramp, at the east boundary of the lot, the shovel proceeded to dig the trench down to —40 ft. below grade. Immediately behind the shovel and above it parallel-chord wood trusses of 8-ft. depth and about 40-ft. span were placed between bearing mats on the inclined earth banks, bracing the exterior banks against the central cores. The shovel continued around to the end of the trench cutting it to the new level of —40 ft. and the truss-braces were set around the border of the lot. This process was repeated on the north boundary.

As the shovel was withdrawn from the completed circumferential trench the exterior footings were poured. Then the exterior walls were built up to grade. A wood rampway was then built along the south border of the lot, and the central cores were excavated, the trusses used for bracing being replaced by inclined shores bearing against the concrete exterior walls and footings. Serious contingencies were avoided by bracing the earth banks as soon as the steam shovel exposed them, the efficacy of the adopted method being attested by the fact that only one minor earth slide of about 30 cu.yd. took place.

The earth cores in the center furnished a well located working space for material storage and equipment used to construct the exterior foundations and walls.

The final grade of the ramp was too steep for the loaded trucks to climb under their own power. It was therefore necessary to install a hoist which operated a steel cable passed through a double-pulley block attached to a deadman buried at the top of the rampway. Trucks were also lowered into the excavation in this manner.

To avoid saturation of the earth banks by the extraordinary rain during the excavation, first canvas and then 1x6-in. lumber (later used as form lumber) was placed over the edges of the bank diverting the rain into the hole from where it was lifted in two stages into the street by centrifugal pumps.

The garage was constructed for the May Co., Los Angeles, by the Herbert M. Baruch Corp., contractors of the same city.

Road Building in the Deserts of Chile

Wheelways of Tar-Treated Gravel and Stone in 18 x 30-in. Trenches in Desert Soil Are Serving Truck Traffic

By William E. Rudolph
Chuquicamata, Chile

DUE to lack of precipitation, the western slopes of the Andes forming the northern third of Chile are a barren waste, with a population density of less than one person to the square mile, and nearly devoid of both plant and animal life. Yet the important Chilean nitrate industry, as well as the mass of the nation's mineral wealth, is centered within this arid region. A network of railroad lines serves the more important salitre and mining centers, rail transportation rates ranging from 2c. to 5c. (U. S. currency) per short-ton mile. The smaller mines, and the irrigated lands affording a little agriculture, are not so fortunate; with rail points often 20 miles away, and a branch line at disadvantageous grade requiring perhaps double that distance of expensive construction, carts, mules and llamas have had to be used. Such transportation involves heavy costs, as much as 25c. to 40c. per ton-mile, with the added inconvenience of being slow. Moreover, ore concentrates, sulphur and similar cargoes have a tendency to wear through the burlap bags in which they are packed for animal transportation, entailing losses along the trails and replacements of bags.

It has been found that, with balanced shipments, motor-truck transportation costs can be attained as low as 7c. per ton-mile, based upon the use of a 2½-ton truck with a 2½-ton trailer. This unit includes interest and depreciation upon rolling stock, as well as upkeep of road, but no interest upon capital expenditure for road building. The more common condition is where the inbound freight, consisting of foodstuffs, fuel, machinery, and miscellaneous materials from a seaport or railroad point, equals about one-half of the outbound cargo, with the grade, about 2 per cent, in favor of the heavier shipments. In such cases costs reach 10c. to 12c. per ton-mile, and there are but few instances where 18c. per ton-mile is not sufficient to cover carrying charges applying to the highway investment as well as all transportation expenses. Compared to the older methods of haulage, this shows an appreciable saving, and highway connections to isolated centers of production have been a natural sequence.

Again, where railroad passenger travel requires six to eight hours for a 100-mile journey, upon narrow-gage lines lacking modern accommodations and subject to schedules averaging two or three trains per week, automobile highways parallel to the main arteries of travel are a practical necessity.

Despite the urgent need for highway connections to seaports and to rail shipment points, the economics of but a few particular projects would justify large expenditures. A cheap road for light traffic is the ordinary requirement, and the type of construction indicated in the accompanying sketch has given good results.

Subsequent to grading, the construction consists simply of excavating two parallel trenches spaced slightly less than automobile gage apart, to fairly solid footing. These are filled with stone topped with a layer of finer gravel to which a protective coating of oil is applied. Under traffic a rut is formed in each wheelway, and as each driver strives to keep his car to these ruts, upkeep is required for the pair of tracks only.

The thickness of the runway metal varies with the character of the ground. The flat desert, or pampa as it is called, presents a top surface of detritus consisting of a soft crumbly material surrounding angular rock fragments. As the former is composed of fine particles of sand and saline matter with little or no cohesion, it follows that the trenches must be dug to firmer bottom. This entails excavation to about 18-in. depth. In more rugged country, solid rock occurs a few inches below surface. Gravel is generally raked up from the wind-swept desert. In default of such material it is necessary to excavate and break up the hard costras—solidified salt deposits—for the coarser fill, and to haul the finer gravel to the site by truck. It is hardly

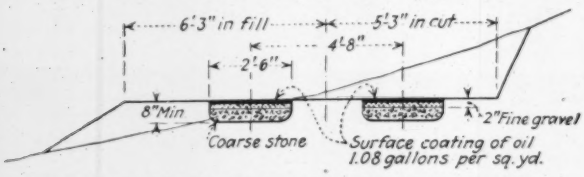
THE ROAD-DESTROYING CART

PRIMITIVE METHODS OF TRANSPORTATION

necessary to add that highway construction is practical only because of the extreme aridity of the region.

The oiling of these roads constitutes a considerable portion of the expense, except where waste oil, discarded because of its content of grit and dirt is obtainable. This feature is therefore not included for highway links of minor importance. The oil used is generally a viscous fluid which has to be heated. It is often applied from five-gallon gasoline cans having holes in the bottom, two men carrying the container as the liquid is spread.

Grades are seldom laid out in excess of 12 per cent, although on some of the older roads mules are still needed for pulling small cars up the hills. On the pampa it is by no means uncommon to have tangents of 30 or



SKETCH CROSS-SECTION OF DESERT HIGHWAY

40 miles length. The heavier cuts and fills allow width for one car only, except where unusual traffic justifies additional expense. Tunnels have been resorted to in a number of cases, the country rock being capable of standing up without lining. No provisions are made for drainage save at crossings of dry quebradas tributary to large watersheds, where corrugated iron culverts are placed to safeguard against the heavy downpours which occur at intervals of ten to twenty years.

Road building is undertaken by private corporations as well as by subdivisions of the Chilean government. The construction organization generally has to operate in an uninhabited country, distant from potable water and food sources. Camps are therefore established for the work, the smallest unit consisting of a foreman, 10 to 20 laborers, camp boss, cook, and watchman. Food, water and fuel are hauled from the nearest supply station by motor truck or six-mule cart. Besides the tents for sleeping and eating, there is usually a portable wood shack for cooking. Separate tanks of potable water for drinking, and brackish water for cooking and washing, are maintained, for the latter is often obtainable at a stream or water hole close to camp, whereas the former is usually at a far distance.

Costs for road work in northern Chile amount to about 40c. per cubic yard for grading in soft material, and $1 per cubic yard in hard rock. These figures include the expense of maintaining men in camp. Surfacing averages about $1,700 per mile, covering the work of excavating and filling the trenches with rock and oiling. This amount is made up as follows:

480 days—laborers at $1	$480
30 days—foreman at $1.60	48
30 days—camp boss at $1.30	39
30 days—cook at $1.20	36
30 days—watchman at .80	24
600 man days—food, water and fuel, at 60c	360
3,160 gal. oil, including railroad freight, at 13c	411
30 days motor truck service at $5	150
Tools, miscellaneous supplies, and charges for camp equipment	50
Engineering, supervision and overhead	100
Total	$1698

All of the above amounts are in American gold, based upon current exchange of 8.15 Chilean pesos to the dollar.

Semicircular Arch Dam Model Tested in Italy

Dam Forming Inner Wall of Ring-Shaped Tank Tested Under Pressure—Other Tests on Concrete Structures

By Prof. C. Guidi
Turin, Italy

A NUMBER of tests of reinforced-concrete structures were made at the International Building Exhibition at Turin, Italy, last year, among which was a test of an arch dam 17 ft. in span and 16 ft. high. By an ingenious experimental arrangement this dam was tested under a head far exceeding the height of the structure. Observations of the elastic deformations of the dam agree closely with those made on the Stevenson Creek test dam in California later in the year.

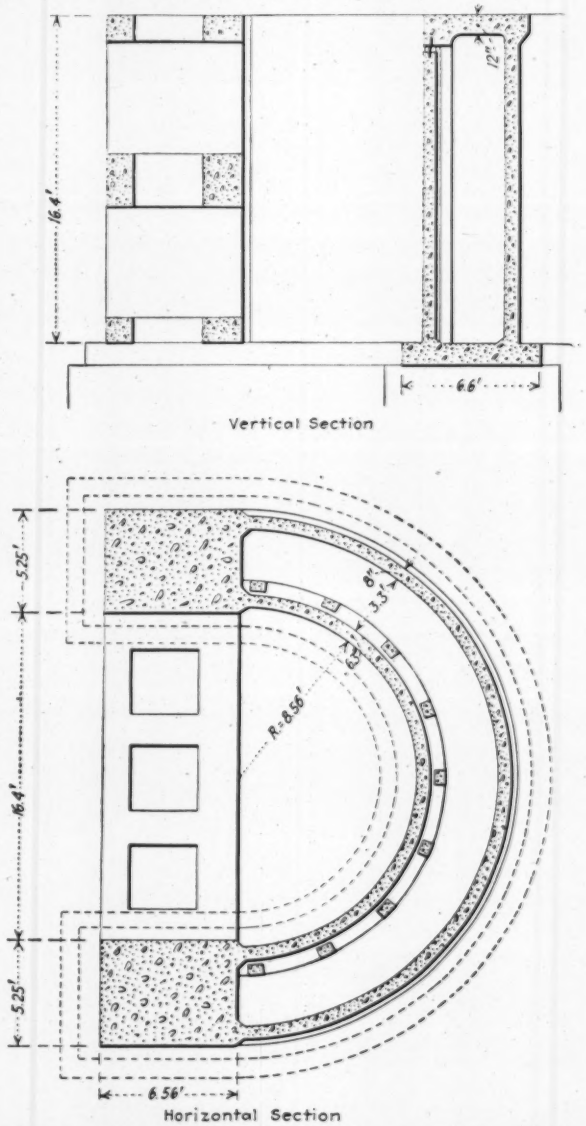


FIG. 1—MODEL ARCH DAM FOR TEST UNDER PRESSURE

The test arrangement is shown by Fig. 1. It is in the form of a half ring-shaped tank, formed by two concentric half-cylinders 3.3 ft. apart in the clear, abutting against two heavy piers which serve as end walls of the tank. These piers are tied together by three pairs of horizontal braced struts. The piers and arches rest on a slab foundation. At the top the tank is closed by a reinforced-concrete slab built integral with the outer arch and connected to the inner arch by a flexible steel seal membrane. The top slab is also tied to the foundation by nine vertical tie rods incased in concrete, to prevent vertical tensile stress in the inner wall of the tank. In this arrangement the inner tank wall represents an arch dam, which can be placed under external pressure by filling the tank with water and applying hydrostatic pressure.

The tests were made under pressures of one atmosphere applied to the water in the tank, thus representing a head of about 50 ft. on the lowest point of the dam. Radial displacements or deformations of the dam were measured at three levels, about 30 in., 70 in. and 9 ft. from the bottom; at each level there were seven measuring points spaced around the semicircle. Provision was made for measuring temperatures, but the tests were carried out rapidly enough to avoid sensible temperature influences. The radial deformations were measured (1) with tank full but not under pressure, and (2) with tank under a head of one atmosphere. By plotting the difference of the two readings the effect of a uniform pressure of one atmosphere on all parts of the dam was obtained.

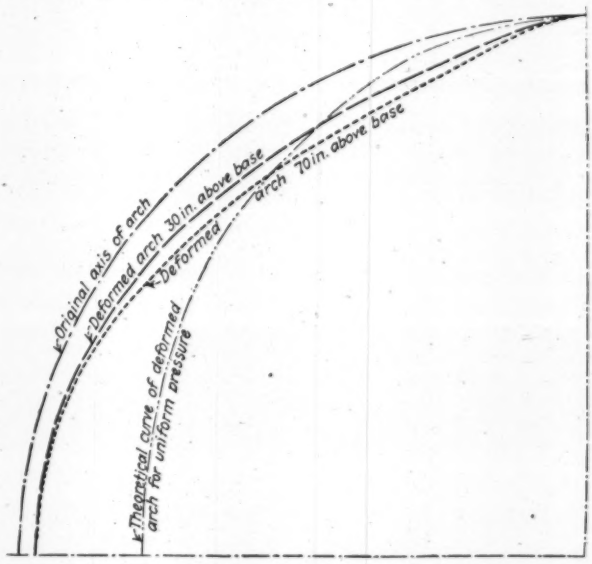

Original axis of arch
Deformed arch 30 in. above base
Deformed arch 70 in. above base
Theoretical curve of deformed arch for uniform pressure

FIG. 2—DEFORMATION OF TEST DAM
Radial deformations multiplied 40 times

Fig. 2 shows deformation curves determined in this manner, the radial shifts being multiplied 40 times for plotting. The deformation at 30 in. and 70 in. from the base are shown by separate lines; a third line gives the theoretical distortion of the arch under one atmosphere computed on the assumption of pure arch action.

These results confirm what the writer stated in the first edition of his pamphlet, "Statica delle Dighe per Laghi Artificiali," or "Analysis of Dams for Artificial Lakes." This is to the effect that the influence of cantilever action is to cause an increased arch load from crown toward abutments.

The experimental results suggest that such dams might suitably be given, instead of a circular shape, a shape of compound curvature having a radius diminishing from crown to skewbacks, and a thickness increasing correspondingly.

It is intended to make further tests to investigate the action of the dam under temperature variations.

Braced Tower—One of the other tests on concrete structures dealt with a reinforced-concrete tower comprising four columns 19.7 ft. high spaced respectively 6½ ft. and 9.8 ft. apart, connected at mid-height and at the top by girders. Vertical loading was applied on platforms on the two tiers of girders, and horizontal loading (analogous to wind load) was applied at the same time. Deflection measurements made on this structure were checked by analytical calculations of deformation. It was found that the measured distortions checked very closely with the calculated ones.

Ribbed-Floor Tests—In another test, two floor or ceiling slabs about 10x25 ft. were tested. One of them was of ribbed construction, with ribs 3x6 in. spaced about 15 in. center to center, while the other was exactly the same except for including hollow tile in the spaces between the ribs. In both floors the slab was 2 in. thick. The floors were tested under a superimposed load of about 65 lb. per square foot. The deflections of the floor without tile ranged from 1.50 to 1.84 times as large as the deflections of the floor with included tile. This relation brought out clearly the large addition to strength provided by the tile, due to the shearing adhesion between the tile and the concrete.

Sewage Farm Covers 13,602 Acres

A SEWAGE farm consisting of 13,602 acres, with 8,084 acres under irrigation, receives sewage from the Melbourne metropolitan district (Victoria, Australia), according to a detailed description given in an article in *The Engineer*, London, Nov. 12, 1926, p. 519. The land is described as being "originally treeless, almost stoneless, open plain country, somewhat clayey and poorly grassed," having an average annual rainfall for 30 years of only 18.14 in. The farm is sown with lucerne or pasture grasses and clover and flooded with sewage and is used for raising hay and grazing. When well grassed, "except in winter or in very wet weather," the sewage farm will take about 3 in. of sewage every two or three weeks, or about 5½ ft. per year, besides the 18-in. rainfall. All the sewage of the district is pumped through one 4-ft. and two 6-ft. mains, 3 miles long, into a gravity outfall sewer 16 miles long. This outfall sewer is partly open channel and partly closed conduit and has a capacity of about 135 U. S. m.g.d.

Dairying is not permitted on the farm, so grazing and the raising of pure-bred cows and sheep are carried on. On June 30, 1925, there were 6,671 cattle, 4,947 sheep and 800 horses on the farm, and about 200 employees. The revenue from grazing, as a rule, is more than sufficient to pay the cost of sewage treatment, apart from capital charges, "while occasionally, in years of drought, the profits are sufficient to pay all charges for purification, including interest." It is claimed that the Melbourne district sewage farm is one of the least expensive and most efficient sewage purification undertakings in the world.

Work of Mississippi River Commission Outlined

Col. C. W. Kutz, a Member of the Commission, Reviews Its History and Limitations—Studies for Extensive Flood-Control Program Based upon Effects of 1927 Flood

Because of the importance of the work of the Mississippi River Commission and of the widespread interest in the studies which it has been making during the past summer, it seems desirable to publish an extended abstract of the paper upon the work of that commission which Col. C. W. Kutz presented at the fall meeting of the American Society of Civil Engineers. His paper is especially valuable as an indication of the general character of the plan for improving flood conditions along the river which the Corps of Engineers will present to Congress this winter. Abstracts from it are given below.—EDITOR.

THE Mississippi River Commission was created by an Act of Congress approved June 28, 1879. It consists of seven commissioners, three of whom are selected from the Corps of Engineers, one from the Coast & Geodetic Survey, and three from civil life. Two of the latter must be civil engineers. The basic law required the commission to "mature a plan or plans as will correct, permanently locate and deepen the channel, and protect the banks of the Mississippi River; improve and give safety and care to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade and the postal service."

Turning back to the earlier years on the Mississippi before the appointment of the commission, Col. Kutz describes briefly the conditions along the river and enumerates some of the historic circumstances which not only led up to the formation of the commission, but also had a direct bearing upon its earlier work. Chief among these were the floods of 1849 and 1850 which caused widespread damage in the valley and resulted in the passage of the Swamp Land Act in 1850, an act which granted to the states in the Lower Mississippi Valley all unsold swamp lands and overflow lands within their limits, to be sold to provide funds to reclaim the district subject to overflow. The same year Congress appropriated the money "for a topographical and hydrographical survey of the delta of the Mississippi with such investigations as may lead to determine the most practical plan for securing it from inundation." This work was first placed in charge of Capt. J. A. Humphreys and subsequently under Lieut. Henry L. Abbot, who had been assistant to Capt. Humphreys. The report was completed in 1861 and is known as the Humphreys and Abbot report.

The next milestone in the history of the Lower Mississippi was an act of Congress, 1874, appointing a joint civil and military commission to make a full report upon the best system of permanent reclamation and redemption of the alluvial valley from inundation. The report of this board, submitted in 1875, was based upon the results of the Humphreys and Abbot survey, and upon additional data secured subsequent thereto. Its conclusions were, "No practicable aid can be derived from any diversion of tributaries or by artificial reservoirs; that cutoffs are very pernicious, and that outlets, though correct in theory, find no useful application to the Mississippi." A general system of levees was recommended.

The Mississippi River Commission was created four years later. In its first report (1880), it advocated a plan which would concentrate, rather than disperse, the waters of the river. It also condemned the outlet system as a means of flood control, expressing the belief that no surer method of ultimately raising the flood surface of the river can be adopted than by making lateral outlets for escape of its flood waters.

As a means of protection against floods, the commission recommended levees as essential to prevent destruction to life and property by overflow. It was not agreed as to the value of levees as an auxiliary to a plan of channel improvement.

The first appropriation for improvements to be built under the commission's direction was made in 1881, but work was hampered by a provision written into the act "that no portion of the sum hereby appropriated shall be used in the repair or construction of levees for the purpose of preventing injury to land by overflow or for any other purpose whatever, except as a means of deepening or improving the channel of said river." This was done on account of the fact that the Swamp Land Act had made it possible for the states in the lower valley to obtain funds for such purposes. Congress held to this view until 1890, and it was not until the Flood Control Act of 1917 that flood control became definitely a part of the commission's work in river improvement. That act provided that the right-of-way for levees for such purposes be provided by local interests and that they pay not less than one-third of the cost of construction and all the cost of maintenance.

Early Work Too Light

Levees—As the work of the commission progressed, it was found that the levees built in the earlier days were far too small for the needs of the river, and as a consequence the size of the levee section was increased until after the floods of 1912, a new standard levee section was adopted and a levee grade line with a 3-ft. freeboard above the level of that flood was established. At the time of the 1927 flood, this work had been in progress for 13 years and two more years would have been required for its completion at the rate at which funds were being appropriated.

The annual report of the commission for 1927 shows a total expenditure to date for levees by the United States from federal funds of $71,000,000 and an expenditure of the United States from funds contributed by local levee districts of $15,000,000. In addition to this expenditure by the United States of $86,000,000, state and local organizations, prior to and since the creation of the Mississippi River Commission, expended approximately $152,000,000 on levees and in expenses incident thereto such as rights-of-way, repair work, high-water expenses, etc. This combined expenditure of $238,000,000 is represented by 1,880 miles of levees containing approximately 500,000,000 cu.yd. of material. This shows an expenditure of slightly less than 50c. per cubic yard of material now in the levees, the difference between this and actual cost per cubic yard being represented by lost or abandoned levees, by expenses for maintenance and repair, and in the cost of closing crevasses and fighting floods.

In six years, from 1918 to 1924, the lost or abandoned yardage amounted to 15,000,000, about 0.7 of 1 per cent per annum of the average annual contents of the system. The losses have been due partly to the necessity of abandoning old lines where threatened by caving banks and partly to changes in alignment in order to secure better foundations. The caving of banks is much the greater cause of losses and bank revetment is the only remedy for this evil.

Bank Revetment—A number of years ago it was estimated that of the 2,000 miles of bank-line between Cairo and the head of the passes, more than 700 miles were in need of revetment. The funds available for such work, however, have never been sufficient to justify undertaking the work on a large scale or in a systematic manner. Each year it has been necessary to confine revetment work to cases of the most urgent necessity, such as threatened cutoffs or endangered levees that could be replaced only at excessive cost. Even though the work has of necessity been prosecuted in this haphazard manner, there was in place, at the end of the fiscal year 1927, 128 miles of revetted bank.

To the end of the last fiscal year the commission had expended in new revetments and in repairs and renewals $61,000,000, an average of $475,000 per mile of effective revetment.

In addition to its expenditures in levees and revetments, the commission is maintaining and operating a fleet of dredges at an average annual expenditure of $600,000 in order to maintain over bars during low water periods a navigable depth of 9 ft.

As revetment work progresses the material annually caved into the river will decrease and it is anticipated that this decrease in the amount of material in motion will greatly improve the low-water channel and decrease expenditures for dredging.

The Mississippi River Commission, Col. Kutz added, has been working towards a *limited* objective, at a rate fixed by Congress. It has many times been importuned to provide special relief for New Orleans by the construction of spillways above or below the city in order that it might be spared the expense of raising its wharves to the 1914 levee grade, but has never felt justified in so using its funds.

Flood of 1927

The rainfall throughout the valley of the Mississippi River which caused the flood of 1927 was extraordinary in volume and in duration and it occurred at a time when the natural storage in the Mississippi itself and the storage basins contiguous to it in the delta was already well filled. The rainfall in eastern Oklahoma, western Arkansas, and southern Missouri was unprecedentedly heavy and caused discharge from the Arkansas River almost as great as that of ordinary high water in the Mississippi itself.

It is difficult to compare the magnitude of different Mississippi River floods at a given point by comparison of maximum measured discharges alone, for at the same gage height the discharge will vary widely due to differences in slope, and the slope, in turn, will depend upon the extent to which the river basin is filled and upon the rate of rise.

Columbus, Ky., 22 miles below the mouth of the Ohio River at Cairo, is a gaging station, and discharge measurements made there or in that vicinity are available for each flood year since 1892. As a check on the observed discharges it is customary to assemble the amount contributed by the Mississippi and the amounts contributed by the Ohio at Evansville and its principal tributaries below that point.

Table I shows that the maximum observed discharge at Columbus in 1912 and 1913 was nearly 300,000 sec.-ft. more than was measured in 1927, yet the maximum gage reading in 1927 was 1.6 ft. higher than in 1913. These differences are believed to be due in part to differences in the shape of the flood crests, and more particularly to an incomplete levee line in 1912 that induced a slope and velocity that were abnormal at the time the discharge was measured. In the 1927 flood a foot on the gage at and near the maximum stage corresponds on the average to a flow of 60,000 sec.-ft., and as no flood of the past shows a smaller average discharge that ratio has been used by the commission in its present plans and estimates.

The maximum discharge past the latitude of Arkansas City in April, 1927, has been estimated at 2,662,000 sec.-ft. This is 250,000 sec.-ft. more than in 1912 and about 200,000 sec.-ft. more than in 1916.

The estimated maximum outflow from the latitude of Old River was 2,350,000 sec.-ft., about 300,000 sec.-ft. less than at Arkansas City. If to this difference we add the flow of the Yazoo and the Red River, we have a measure of the regulating influence of storage on the lower ends of the Yazoo and Tensas basins and in the river itself.

New Flood and Levee Studies

During the last four months the commission has been working on a new plan, and although Col. Kutz was unable to divulge the details of that plan, he was able to give the following outline of the way in which it has been approached:

As a basis for a new project, it was determined to set up a probable future maximum flow at Cairo. The discharge at Cairo in 1927 was approximately 1,800,000 sec.-ft. In determining how much larger flood should be provided for, consideration was given to the fact that if to the maximum discharge of the Mississippi at St. Louis there was added the maximum discharge of the Wabash at Mt. Carmel, the Ohio at Evansville, the Cumberland at Nashville, and the Tennessee at Florence, the total would aggregate over 3,000,000 sec.-ft. If the maximum discharge of the Ohio and the maximum discharge of the Mississippi at Cairo were added, the total would be about 2,700,000 sec.-ft. If to the estimated discharge of the 1927 flood, (1,800,000) there be added the difference in flow, at flood stages, of the Ohio in 1913 (maximum) and in 1927, the total will be 2,400,000 sec.-ft.

All of these combinations may be classed as "possibilities," but it does not seem probable that rainfall sufficient to produce such coincident floods will ever occur. In its determination of this question the commission gave full consideration to the views of the local weather bureau meteorologist at Cairo and to the views of the Chief of the U. S. Weather Bureau. For the purposes of this paper it is proposed to assume 2,250,000 sec.-ft. as the probable maximum flood of the future at Cairo. If the relation between gage and discharge established in the 1927 flood were maintained, such a flood, confined by levees, would reach a stage of 65 ft. on the Cairo gage. This assumed discharge is 25 per cent

TABLE I—MISSISSIPPI RIVER DISCHARGES 1890-1927

	Mississippi River at St. Louis c.f.s.	Ohio River c.f.s.	Sum of Preceding Columns c.f.s.	Mississippi River at Columbus Scaled from Rating Curves c.f.s.	Maximum Observed c.f.s.
1890	72,000	1,229,000	1,301,000	1,312,000	
1892	408,000	882,000	1,290,000	1,332,000	1,401,000
1893	601,000	884,000	1,485,000	1,470,000	1,528,000 (a)
1897	283,000	1,240,000	1,523,000	1,464,000	1,462,000
1898	283,000	1,079,000	1,362,000	1,393,000	1,517,000
1903	377,000	1,016,000	1,393,000	1,426,000	1,483,000
1904	383,000	994,000	1,377,000	1,389,000	1,502,000 (b)
1907	429,000	918,000	1,347,000	1,436,000	1,543,000
1912	592,000	1,110,000	1,702,000	1,733,000	2,015,000 (c)
1913	323,000	1,395,000	1,718,000	1,750,000	2,015,000 (d)
1916	617,000	869,000	1,485,000	1,497,000	1,775,000
1917	285,000	994,000	1,269,000	1,362,000	1,420,000
1920	446,000	869,000	1,315,000	1,422,000	1,527,000
1922	311,000	1,137,000	1,448,000	1,520,000	1,501,000
1927	800,000	814,000	1,614,000	1,800,000	1,728,000 (e)

(a) Another measurement at same stage gave 1,434,000 sec.-ft.
(b) Another measurement at about same stage gave 1,447,000 sec.-ft.
(c) Measured at 48.5 ft. stage. At the maximum stage the discharge measured 1,854,000 sec.-ft.
(d) Mean of seven consecutive measurements was 1,959,000 sec.-ft.
(e) Cairo gage was 53.7 ft. at time of observation.
The sum of discharges at St. Louis and from the Ohio does not represent the total at Columbus because it does not include runoff from the Meramec, Kaskaskia, Big Muddy and a number of smaller rivers.

greater than that of 1927, a factor of increase relatively much larger than that assumed in the Miami Conservancy project, when the relative magnitude of the two drainage areas is considered. If protection against such a flood were provided by levees alone it would require an increase in levee heights as shown in Table II.

This increase in levee height is based upon a 5-ft. freebroad instead of the 3-ft. freeboard heretofore used, a modification that was generally recommended by the engineers of local levee districts as a result of their experience with the 1927 flood.

These levee engineers were also practically unanimous in recommending that the levee section be strengthened by flattening the riverside slope from 1 on 3 to 1 on 4, by increasing the crown width from 8 to 12 ft., and by flattening the landside slope so as to completely contain a saturation line

TABLE II—PREDICTED LEVEE GRADES

Miles Below Cairo	Station	New Levee Grade	Existing Levee Grade	Increase in Levee Heights
0	Cairo	70.4	58.0	12.4
22	Columbus	64.7	52.7	12.0
71	New Madrid	56.5	47.6	8.9
227	Memphis	58.4	51.5	6.9
307	Helena	71.0	58.5	12.5
392	Mouth of White River	78.4	61.9	16.5
437	Arkansas City	79.5	60.5	19.0
480	Greenville	72.8	55.8	17.0
543	Lake Providence	69.1	53.7	15.4
602	Vicksburg	72.0	58.0	14.0
602	St. Joseph	68.7	54.0	14.7
706	Natchez	72.7	57.5	15.2
773	Red River Landing	69.5	57.5	12.0
841	Baton Rouge	57.9	48.1	9.8
894	Donaldsonville	46.4	39.0	7.4
965	Carrollton (New Orleans)	30.8	25.2	5.6
1,047	Fort Jackson	14.4	11.0	3.4

of 1 on 7 springing from a point on the riverside slope 2 ft. vertically below the crown. The flattening of the riverside slope was advocated largely as a means of protection against wave wash. The increased freeboard and increased width of crown were advocated as increased factors of safety, and the flattening of the landside slope was for the purpose of reducing seepage during long continued high stages. To increase the levees to such heights and to increase the section as outlined above would require an expenditure for main river levees alone of more than $500,000,000.

Reservoir Possibilities

As high floods in the Mississippi have crested at Cairo between Feb. 22 and May 9 except in 1916, and as the floods flatten out to a period varying from 20 to 80 days at Vicksburg, Col. Kutz believes that headwater reservoirs to be effective must store water for a period of about 90 days.

Data relating to 245 possible reservoirs were examined and from storage graphs there was determined the percentage of reservoir capacity which could be utilized each flood year.

A first study concerned headwater reservoirs above Cairo and assumed them to be operated solely in the interest of Mississippi river flood reduction. Reservoirs having an aggregate capacity of 71,000,000 acre-ft. were considered, the cost per acre-foot ranging from 50 cents to $112. A storage cost curve was prepared based on storage at a uniform rate during the storage period, on an efficiency as measured by the amount of water stored equal to 75 per cent of reservoir capacity, and on a relation between gage and discharge at Cairo of 1 foot equals 60,000 sec.-ft. From this cost curve it appeared that the cost of reducing flood heights at Cairo would range from $62,000,000 for the first foot to $230,000,000 for the fourth foot, and that a reduction of 4 feet by means of such reservoirs, equivalent to 240,000 sec.-ft., would cost $560,000,000.

A more detailed analysis was then made using actual rates of storage instead of assumed uniform rates and actual efficiency of reservoirs instead of an assumed average of 75 per cent. Allowance was also made for the effect of storage in the river valleys between the reservoirs and Cairo. This more detailed study was limited to the Ohio basin and comparison made between the floods of 1913 and 1922. The effect of valley storage was determined approximately by showing graphically the relation between the inflow into the Ohio river from its tributaries and the outflow as measured near its mouth. The composite inflow graph of all the tributaries was synchronized with respect to the outflow graph by taking into consideration the time of travel of water from the mouth of each tributary to the mouth of the Ohio. The difference between the inflow and the outflow curve appears to be a direct measure of the effect of valley storage and the true effect at Cairo of reservoir storage in the Ohio basin can only be determined by taking into consideration the modifying influence of valley storage. The 1913 flood in the Ohio valley was characterized by a sharp peak while that of 1922 was a long low flood. In the latter, valley storage was a much less important factor than in the former.

Cost and the effect of reservoirs next was analyzed on the assumption of joint use, that is, a combination of Mississippi River flood control with local flood control, with the development of power, with improvements for navigation, or a combination of three or more uses. Many such combinations were found to be possible and although some uses are more or less conflicting it was found that generally such joint use would result in some reduction in the cost per acre-foot chargeable to Mississippi River flood control.

After the data concerning all the reservoirs had been examined the most desirable ones, as determined by the ratio of benefits to cost, were selected for further study.

This group had a capacity of about 38,000,000 acre-ft., the average gross cost being between $10 and $11 an acre-ft., and the net cost chargeable to Mississippi River flood control between $7 and $8 an acre-ft. To reduce flood heights at Cairo by this selected group would require a gross expenditure for the first foot of reduction of $104,000,000, or a net expenditure chargeable to the Mississippi River of $40,000,000, assuming that the other interests benefited could be induced to pay the difference. The second foot of reduction would cost $160,000,000, of which it is estimated that $17,000,000 could equitably be charged to other interests. The average effect of this group in reducing gage heights at Cairo during past floods would have been 2.65 ft., and had the entire group been built the average net cost under the assumptions made would be $115,000,000 per foot of reduction on the Cairo gage, or nearly $10,000,000 per inch of reduction. Expressing the reduction in terms of discharge, the cost would average $190,000,000 per 100,000 sec.-ft. for a maximum reduction of 159,000 sec.-ft.

Suggested reservoir sites in the St. Francis, White and Arkansas basins were also considered. These reservoirs are generally located in areas of high rainfall which are important contributors to floods in the lower Mississippi, and the proposed reservoirs are of such size that their capacity could be effectively utilized during most Mississippi River floods. These reservoirs have a gross capacity of 25,000,000 acre-ft. and are estimated to cost $215,000,000, or $8.50 an acre-ft.

Studies were also made of suggested reservoirs in the St. Francis, Yazoo and Tensas basins. About 30 years ago James A. Seddon proposed a series of reservoirs in the St. Francis basin as a means of regulating Mississippi floods. A similar plan, modified to conform to developments that have

taken place in the basin since that date, was considered, but the cost of storage was found to be approximately $27 an acre-ft. Estimates were also prepared of the cost of reservoirs at the lower ends of the basins. Such reservoirs would substitute controlled storage for the uncontrolled storage which now exists at the lower ends of these basins, and the cost of such reservoirs must be balanced not against their value in reducing flood heights but against the difference in value of controlled and uncontrolled storage.

Outlet and Diversion Channels

The reduction of flood heights in the lower Mississippi River by the diversion of part of the flood waters has been the subject of discussion for many years. In presenting the matter Col. Kutz uses the following terms:

An *outlet* is a natural channel serving to extract water from the river at all stages and conduct it directly or through collateral waterways to the Gulf. A *diversion* channel is an artificial one serving to divert part of the main river flow to the river at a lower point or by independent collateral channels to the Gulf, the flow into it wholly or partly under control. A *spillway* is a structure designed to afford regulated entrance of flood waters into a diversion channel.

At the present time there is an outlet at Old River 202 miles above New Orleans. Old River is a link connecting the Mississippi with the Red-Atchafalaya System. It serves as a relief to Mississippi flood water except when higher flood stages in the Red-Atchafalaya System cause a reversal of flow. To a limited extent, it is used for light draft navigation, suitable depths being maintained by dredging.

While described as an outlet its size and the flow through it at low stages are controlled to some extent by several mattress sills near Simmesport. This route to the Gulf is 150 miles shorter than by way of the main river. It is now leveed on the upper 40 miles and its capacity at flood stage is about 400,000 sec.-ft. It has been suggested that the levees on one or both banks be set back so as to create a floodway with a capacity of 900,000 to 1,000,000 sec.-ft. To secure such a flow without excavation would require a width between levees of 6 to 8 miles and entail the acquisition of extensive flowage rights through what is known as the sugar bowl of Louisiana.

Whether such a floodway should be controlled by a spillway so as to confine in the main river all or part of the flow below a bankfull stage is an important question. Such a spillway would interrupt navigation between the Mississippi and the diversion channel unless a lock were also provided. On the other hand, unless controlled, so large a diversion may cause silting in the main channel to such an extent as to interfere with navigation at low stages and to diminish its flood carrying capacity at high stages.

Diversion Through the Tensas Basin

A diversion channel through the Tensas Basin with capacity ranging from 600,000 to 750,000 sec.-ft. was also considered. Such a channel would leave the main river at or near the mouth of the Arkansas and extend to the upper end of the proposed floodway through the Atchafalaya Basin. Study was also made of a diversion channel through the St. Francis Basin, with capacity ranging from 300,000 to 500,000 sec.-ft. Unless such a channel were extended to the White River and thus connected with the Tensas Basin diversion, it would not permanently divert water from the main channel.

In addition to these three major diversion plans, consideration was given to the construction of several short diversions with capacity of 250,000 to 300,000 sec.-ft. above and below New Orleans, primarily for the protection of that city.

Diversion of part of the flood flow through the St. Francis Basin will apparently cost more than to confine the entire flow between levees on the main river. Diversions through the Tensas and Atchafalaya Basins are far more promising from the standpoint of first cost. Even though cheaper than the plan which would confine the entire flow between levees, the creation of such secondary channels for the discharge of part of the flood flow can be justified only if the opponents of diversion channels are mistaken in their belief that they will not permanently lower flood heights.

Touching upon the subject of whether the use of outlets or spillways will cause silting of the channel below the point of diversion, Col. Kutz says that the belief that the Mississippi River is so charged with sediment that the reduction in slope and velocity below a controlled diversion channel will cause deposits is not borne out by the findings of Humphreys and Abbot. Furthermore, if the diversion is so built that it will not come into action until after the river reaches a bankfull stage (approximately 1,000,000 sec.-ft.) and so controlled that the flow through it can be reduced as soon as the crest passes, the changes in slope and velocity can be kept within such narrow limits that deposits of silt should not occur.

Opponents of outlets point to the changes that have taken place at Red River Landing where from 300,000 to 400,000 sec.-ft. have been diverted at flood stages from the Mississippi through the Atchafalaya to the Gulf of Mexico. The flood of 1882 reached a stage of 48.5 ft. at Red River Landing when the discharge was slightly more than 1,500,000 sec.-ft. The same discharge reached a stage of 53.2 ft. in 1912 and 57.5 ft. in 1927. This increase in flood heights between 1882 and 1927 is attributed by the opponents of outlets to a deterioration in the carrying capacity of the channel due to the effect of the outlet through the Atchafalaya.

Conclusions

In summarizing his conclusions Col. Kutz states:

Protection against a probable maximum flood at Cairo of 2,250,000 sec.-ft. can be provided by enlarging and strengthening the existing levees, but no matter how well the levees are built, nor how well they are protected by revetment of the banks, an 1,800-mile levee line of the height necessary to contain such a flood would carry with it a menace to the people living behind it that should be avoided if practicable.

Reservoirs as a means of reducing levee heights will apparently cost very much more than a series of diversion channels or floodways through the delta basins.

Some of the proposed diversions will apparently justify themselves from an economic standpoint in that they will cost less than corresponding increase in levee heights; others will cost more but may be justified by reason of the greater safety that they will afford to the inhabitants.

Such secondary channels are not substitutes for levees on the main river. Even with all the proposed diversion channels built, the existing levees will have to be maintained and even increased in height in order to provide protection against the assumed flood of 2,250,000 sec.-ft. at Cairo.

Whatever may be assumed as the probable maximum flood of the future, an even greater flood may some day occur, sufficient to overtop the levee line. To provide for such a contingency, it has been proposed to construct along the crown of the levee a series of over-bank spillways that would be brought into play only when overtopping was imminent. Such structures would provide the means of substituting a minor disaster for a major one and permit prompt recovery from the effects of such a superflood.

In the opinion of the speaker, the most dependable method, as well as the cheapest method of protecting the delta basin of the Mississippi River against a probable future flood lies in a system of main river levees, supplemented by a series of controlled diversion channels through which excess flood waters can be carried to the Gulf.

As an integral part of such a flood control plan, the main river should be stabilized by revetting the caving banks. While such stabilization is regarded as an essential part of the flood control project, it will also greatly benefit navigation at low stages.

Concluding a Series of Eight Articles on

Winter Construction Methods and Plant

BY C. S. HILL
Associate Editor, Engineering News-Record

1. Planning and Servicing Winter Construction
2. Winter Care and Servicing of Equipment
3. Winter Excavation and Embankment Construction
4. Concrete Road Construction in Winter
5 Winter Heating Concrete Materials and Mix
6. Handling and Placing Concrete in Winter
7. Protecting Winter Placed Concrete
8. *Winter Inclosure in Building Construction*

8. Winter Inclosure in Building Construction

PROFICIENCY in winter construction has reached its highest development in building work. Building contractors of the higher class today make no distinction between seasons in undertaking and prosecuting construction. Their methods do not extend beyond or differ from those employed in other engineering construction in winter but they have them more completely standardized and more highly perfected particularly in the ways and means of sheltering and heating both the working operations and the finished work. It is this phase alone of winter concrete building that will be considered here. Alumina cement concretes and high early-strength concrete mixtures have not been used to any considerable extent as a means of combatting frost in building work. The use also of admixtures like calcium chloride has been only occasional. Instead dependence is put on the use of heated concrete and of inclosing the work and keeping it warm for the longer period necessary to safeguard conventional mixtures. The nature, action and possible utility of these special mixtures for winter construction were considered in Article 6. Methods of heating concrete and insulating covering and form insulation were considered in Articles 5 and 7.

General Requirements—Concrete as used in buildings in thin floor and wall slabs and in slender column and girder forms offers little resistance to frost action. When freezing occurs there is positive structural hazard. These facts have so often been demonstrated by disaster that argument need not be extended. All the structure of a concrete building must be protected and kept warm till the concrete has gained strength. There may be no safe deviation from this rule.

Progressive Canvas Housing—Protection by inclosing progressively portions of the building with canvas curtains and heating the inclosure is the most common practice. In general the procedure is: as the structure goes up story by story, each story or portion of a story is inclosed, Fig. 32, progressively with the concreting operations, the housing, generally canvas curtains, being taken down from the cured work and re-erected ahead for new work. The heating arrangements are shifted with the housing. Methods are best explained by an account of typical good practice and then noting differences in practice and special details.

For any story, with the forms erected for columns and floor, hang canvas curtains from the exterior beams of the floor to be concreted and lash their bottoms in under the exterior beams of the floor below. In hanging the curtains brace them out from the building so that there will be space between them and the exterior column and girder forms for the circulation of warm air. Also carry their bottoms well below the exterior column footings and bind them in tight, Fig. 33. Here at the column bottoms is the frost danger point. With the exterior curtains hung, carry across the building partition curtains shutting in the section being concreted. This normally completes the inclosure. In it for heating, locate a salamander at each exterior column form and one at the middle of each bay; in extreme cold weather place a salamander each side of each exterior column. It may be also desirable in this frost danger zone to supplement heating and curtaining with hay packing or other insulation. The requirement is that in all parts of the inclosure the temperature must be kept at 60 to 80 deg.

In climates of continued extreme cold or when the progress is exceptionally rapid it is necessary to curtain the story below that being concreted, or, rather, leave the original curtaining in place, and to heat it with a salamander at each exterior column for at least two days. This story-below housing is also necessary if concrete exterior walls are being carried up monolithically with the columns. Fig. 34 shows a recommended arrangement; generally the heat holes are needed only in the case of blank walls.

In beginning concreting, the side curtains should be in place and fires going in the salamanders. If the cold is extreme, inclosure and heating had better precede concreting by several hours. The next step is to remove with steam jets any snow in the forms or any ice on the steel. These operations should be performed after the work is inclosed and heated or else the steam vapor will again form ice. Practice in concreting columns approves both pouring a day ahead of pouring the floor and pouring columns and floor slab monolithically the same day. In the first instance inclosure and heating must have

been installed and protection provided for the column tops; in the second very great care must be exercised to make sure that there is not shrinkage cracking between the column top and the floor slab.

The inclosure described leaves the slab concreting unprotected. This requires separate covering as the work progresses. As soon as a bay of slab is poured it should be covered, Fig. 32, by a tenting of canvas. A common method is to clamp 2x6-in. pieces to the column steel and on them set 4x6-in. timbers spanning between columns. On these girder timbers lay 3x4-in. joists and over them spread canvas with care to give plenty of overlap and to make it everywhere fast and tight. The clear height of this covering should be 6 in. and not over 18 in. Instead of pieces clamped to the column, steel supports set on the column concrete or on the wood frames of the heat boxes may be used to carry the framework. To get heat under the covering, holes are left in the slab forms and slabs to the inclosed heated story below. An 8x12-in. hole for each bay under 20 ft. square or elsewhere a hole for every 300 sq.ft. of slab is required. A temperature of 50 to 70 deg. under the top covering is required. Designs for the slab protection described are given in Fig. 35.

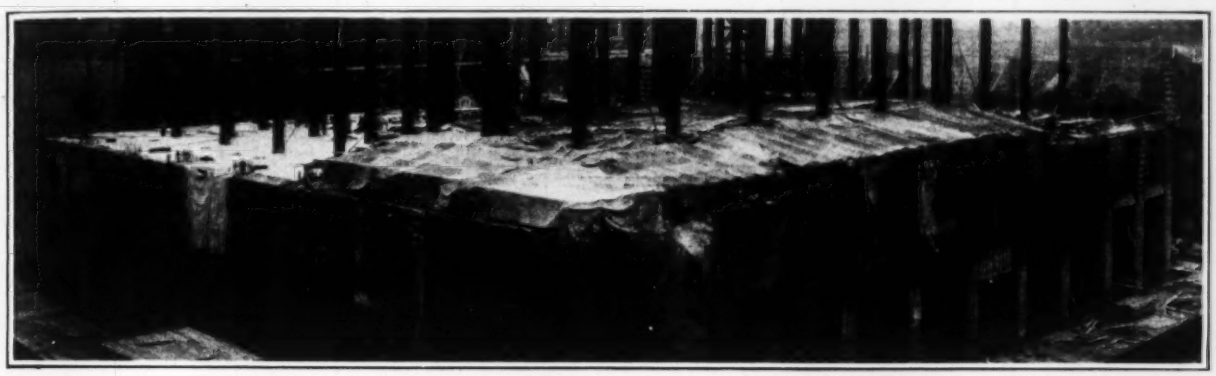


FIG. 32—TYPICAL WALL CURTAIN AND FLOOR COVER INCLOSURE

Proper protection as described involves verification of temperature constantly as the work goes on. A blank for reporting thermometer records is shown by Fig. 36. It calls for two thermometers at two different places and for five readings each 24 hours. The time and manner of removing protection vary with the type of construction. For slab and girder floors the top covering may be removed in 48 hours, at the time covering the heat holes with boards. In 48 hours too the exterior columns may be stripped but it should be done quickly so as to require loosening of the side curtains for as little a time as possible. The side curtains can be removed in 96 hours and the girder forms stripped, and 24 hours later all the forms. In flat slab construction the top cover should remain 72 hours when the exterior columns may be stripped. The side curtains may be taken down in 120 hours when the floor forms can be taken down.

Virtually the same procedures are followed in steel-frame buildings having concrete floors. The wall construction—brick, tile, stone, follows after the frame and floor construction and is independently housed. A good example of brick wall work protection is shown by Fig. 37.

The preceding methods of progressive protection are based on the practice of the Turner Construction Co., New York. The practice of other good builders differs only in detail. In covering the floor slab some prefer a higher shelter, Fig. 38, so that finishers can work under it. On building work in St. Louis (Fruin-Colnon Contracting Co.) a frame was set up over each bay as it was poured. A 2x4-in. post was set up over each column so as to give 5-ft. clear headroom. This inclosure was heated from the floor below by holes left in the slab about every fourth panel. A salamander was set at the center of each panel and two at each exterior column. The inside temperature was kept at 70 deg. with outside temperatures as low as 10 deg. The materials and labor for heating and protecting the concrete cost about $1.50 a cubic yard.

Another example of high covering is a five-story garage in Buffalo, N. Y. (The John W. Cowper Co.) This building was 150x150 ft., with columns spaced about 25 ft., both ways. Forms were erected for a complete story. On these was set up the housing for the slab. This consisted of a light frame of wood 5 ft. high at the outside and 8½ ft. high at the center. The side curtains were long enough to reach from the top of this housing and inclose the story below. The canvas roof

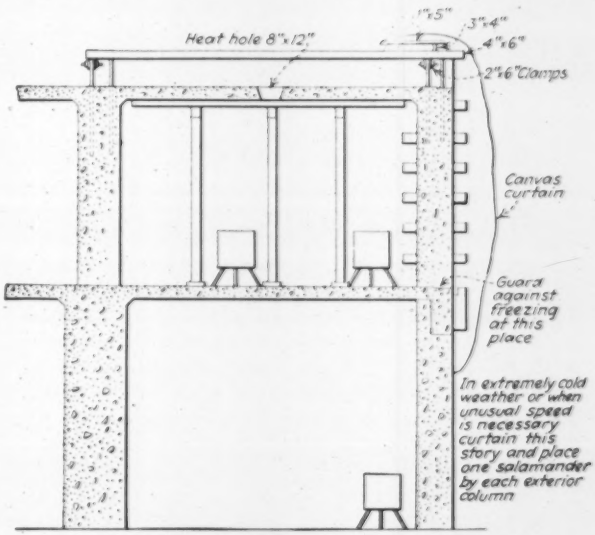

1"x5"
3"x4"
4"x6"
Heat hole 8"x12"
2"x6" Clamps
Canvas curtain
Guard against freezing at this place
In extremely cold weather or when unusual speed is necessary curtain this story and place one salamander by each exterior column

FIG. 33—DETAIL WALL CURTAIN AND FLOOR COVER ARRANGEMENT

was put on in the usual way. To fasten down the roof, lines were thrown over it completely across the building and tightened by twisters. All concrete was poured under this roof. Oil-burning salamanders on the floor

below kept the temperature at 70 deg. While this full housing was rather more costly than the usual construction it saved its cost in keeping forms and steel

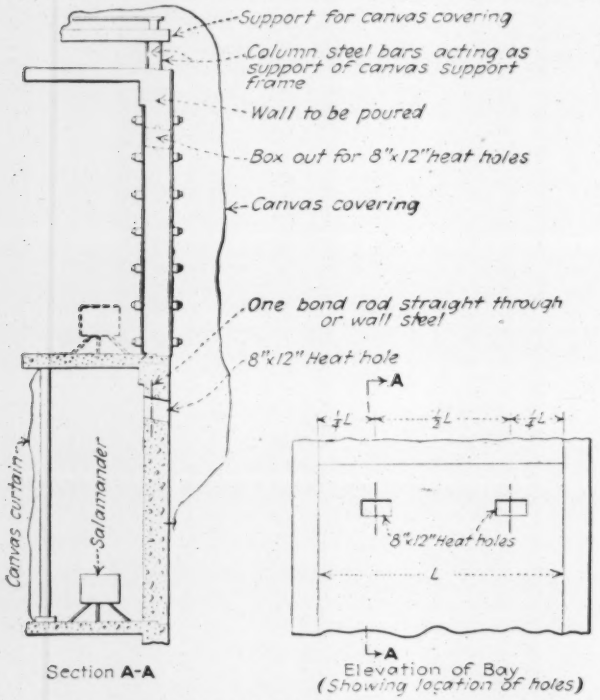


FIG. 34—CURTAIN PROTECTION FOR INTEGRAL WALL CONSTRUCTION

from snow and ice and keeping the men warm at their work. Outside temperatures ranged from 10 to 20 deg.

In place of slab housing, or to replace it after 48 hours, insulating coverings have been used. On a 60x84-ft. building with four floors in St. Paul, Minn. (William Murphy & Son) a floor was poured in a day's run. The story below was inclosed and kept warm by salamanders and camp stoves. As fast as the slab was screeded it was covered with tar paper and a heavy layer of packing hay. This covering and the heat beneath kept the slab from freezing. In building the second story deck of the Wacker Drive in Chicago, in parts hay packing of the under-slab form and a hay covering on top kept the concrete put in at 65 to 70 deg. at this temperature for a week. In a warehouse operation in Montreal both an insulating covering and calcium chloride were called in to supplement the canvas inclosure. This was constructed by spanning 4x6-in. timbers on edge between columns, the timbers being fastened to the column bars. On these timbers 3x4-in. pieces were placed 3 ft. apart, and, on them, canvas. After 48 hours this inclosure was replaced by 12 in. of wheat straw. Tests showed that the calcium chloride with warm material would prevent freezing for an hour with the air at 10 deg. and this was time enough for the canvas protection to be placed. The calcium chloride was used in the proportion of 2 lb. to each sack of cement. It was received in crystals in bags and was stored on the floor above the mixer where a battery of three barrels was used for dissolving the crystals. A steam jet in each barrel was necessary to make the crystals dissolve rapidly. The concentrated solution was piped to the measuring barrel at the mixer. (Parklap, Inc., New York.)

In heating there is very little variation in practice. Salamanders are most used, with coke fuel. Oil stoves are sometimes substituted and in special locations kerosene torches constitute the heater. With coke burners the firing has to be watched. Best results are accomplished, with a minimum of smoke and a maximum of heat, by putting on frequent small amounts of the fuel. Also keeping the coke dry will decrease the fumes. Fire hazard has been considered in Article I. Heat production depends on care and skill in firing and the check on

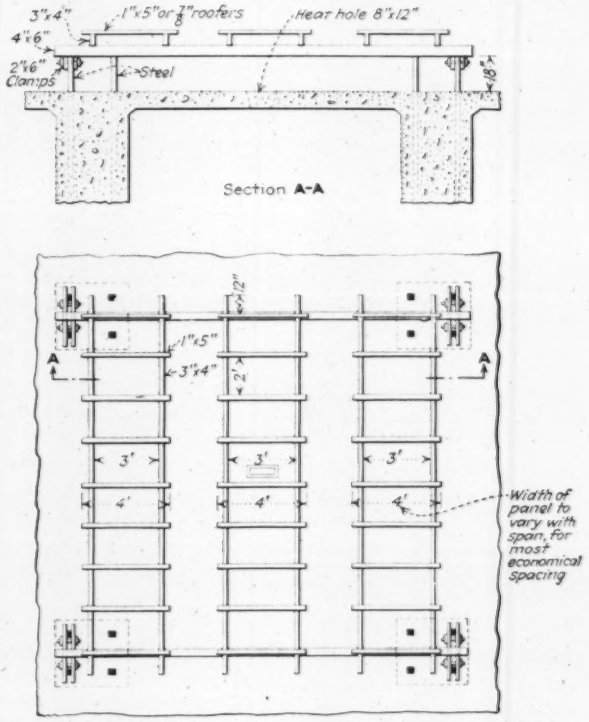


FIG. 35—DETAILS OF FLOOR COVER SUPPORTS FOR CANVAS

sufficient heat is not the number of heating units but it is thermometer readings taken in enough places and often enough to be sure that in all places the inclosure is warm.

On building work in Montreal it was found that to maintain a temperature of 80 to 90 deg. under the bottom of the slab with an outside temperature of 10 to 20 deg.

TEMPERATURE RECORD

Important - Give proper date under each hour column	7 A.M.	1 P.M.	5 P.M.	10 P.M.	3 A.M.
Outside Temperature					
At bottom of Exterior Columns Thermometer No. 1 at Col. No.					
At bottom of Exterior Columns Thermometer No. 2 at Col. No.					
At under side of slab					
Under canvas over slab Thermometer No. 3 at Col. No.					
Under Canvas over slab Thermometer No. 4 at Col. No.					
Temperature of concrete as it is placed in forms					

FIG. 36—FORM FOR TEMPERATURE RECORDS

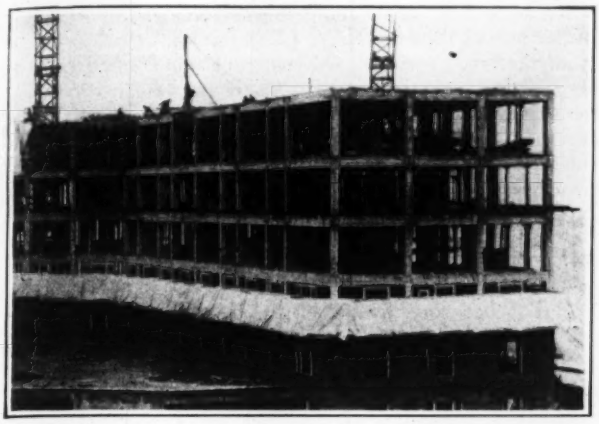


FIG. 37—CANVAS INCLOSURE FOR BRICK MASONS

and a moderate breeze blowing, one salamander was required to each 300 sq.ft. of floor. In order to maintain a temperature of 40 deg. after the concrete had got its initial set, it was found that one salamander was required for 600 sq.ft. of floor, but that more of the salamanders had to be placed near the outside walls and most of them on the windward side. (Parklap, Inc.)

Canvas for curtains, it has been found by leading builders, is most convenient when made up in standard size units. A sketch of such a unit (Turner Construction Co., New York) is shown by Fig. 39. The specifications are:

Covers to be made of 12-oz. U. S. Standard Army Duck 28½ in. wide. Covers to be 20 x 20 ft. finished size and must measure full size without stretching upon delivery. All sewing to be two row lock-stiched with six stitches of five cord Weetamoe soft finish thread or heavier per inch. Seams to be at least 1 in. wide. A 2-in. hem is to be sewn over a ¼-in. pure manila rope all around the four sides of the cover. Each cover to be provided with a ⅜-in. rope stop 6 ft. long after splicing at each corner and to have three additional stops on each side between corner stops. All stops to be whipped on the free end and to be spliced through a sewn-in ring. Place extra sewn-in rings in the hem midway between the above stops. All covers to be made with five 6-in. square patches sewed on to one side of the cover. One of these patches will be placed in the middle of the cover and the other four patches will be placed, one each midway between the center patch and each corner of the cover. To each patch is to be sewn a 1½-in. galvanized iron ring.

Cold Weather Reshoring—Because the concrete gains strength slowly at low temperatures more care has to be taken in reshoring beams and floor slabs. Assuming the beginning of form removal after 48 hours the following has been found to be safe practice: With 20-ft. square panels a 6x6-in. shore at the center of the square and 4x4-in. shore at the center of the bay between columns; a 4x4-in. shore at each corner of the drop panels; and 4x4-in. shores 5 ft. apart under all beams. All this shoring should remain 28 days; then it can be lightened gradually but some shoring should be left in particularly under beams for 56 days. This is heavy safe shoring for very cold weather operations. Judgment and experience will tell when the amount can be lessened but the hazard of cold weather concreting may not be taken lightly and a little extra timber is always good insurance.

Complete Wooden Housing—Complete inclosure of the structure being built by a wooden housing has been employed occasionally for reinforced-concrete buildings but chiefly for steel-frame buildings with brick or stone masonry walls and concrete floors. Generally one or both of two conditions have led to its use: (1) Unusually rigorous winter conditions, and (2) necessity of full completion without possible doubt for early spring use. These characteristics are brought out particularly in the examples selected to display the practice of wooden housing.

One of the earlier of well planned complete housing operations was the building of the Lake Placid club house in northern New York State in 1922-23. The

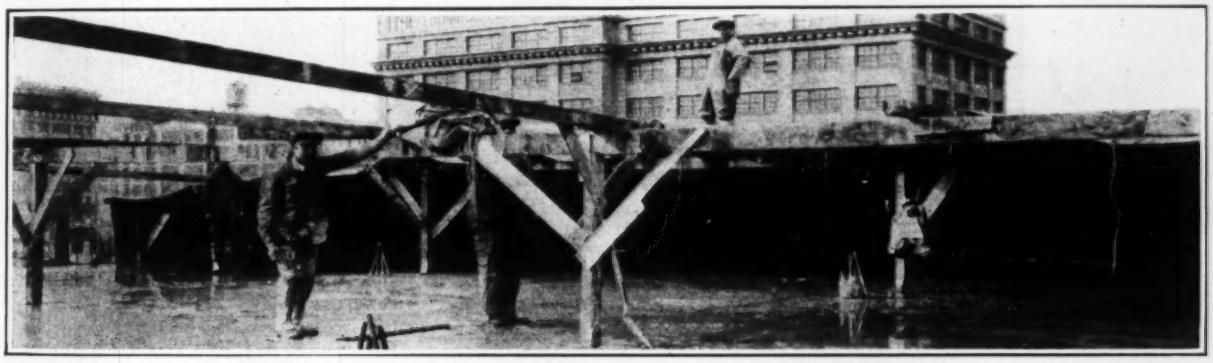


FIG. 38—HIGH FLOOR COVER GIVING HEADROOM FOR WORKMEN

building had a reinforced-concrete frame, lower walls of cut stone and upper walls of brick. The usual temperature of the locality in winter is zero and often the thermometer goes to 20 deg. below zero. The winds are heavy and persistent. Completion by early spring was required. There had to be provided working conditions under which masons, plumbers and interior finishers could work as well as the concrete workers. The housing was built 5 ft. larger than the building laterally and high enough for its roof to span over the completed building roof. The roof trusses were carried on bents to the full height of the walls. These bents were spaced 10 ft. on centers and were built of 3x4-in. posts braced two ways. The exterior walls were 2x6-in. studs spaced 30 in., sheathed outside with ⅞-in. matched boards and inside with tar paper. The temporary housing was self-supporting. It was heated by a vento blower system having a capacity of 15,000 cu.ft. a minute at 150 deg. Wooden ducts distributed the hot air. The existing clubhouse boilers supplied steam at a fuel expense of 3½ tons a day. The average inside temperature was 55 deg. with

the thermometer going down to —20 to —35 deg. About 150,000 ft.b.m. of lumber was required. (Turner Construction Co.)

At the Lake Louise hotel extension in Alberta similar rigorous winter conditions and need for early spring completion dictated complete housing for a nine-story 50x300-ft. building. This had a steel frame, concrete floors and brick and tile walls. The temporary building roof and roof supports were made sturdy to carry snow loads but a light shell was built of tar paper on studding. Steam coils were located about the building for heating. About 150,000 ft.b.m. of lumber were used. (Carter-Halls-Aldinger Co., Ltd., Winnipeg.) An even lighter housing was employed in pier shed construction in Phila-

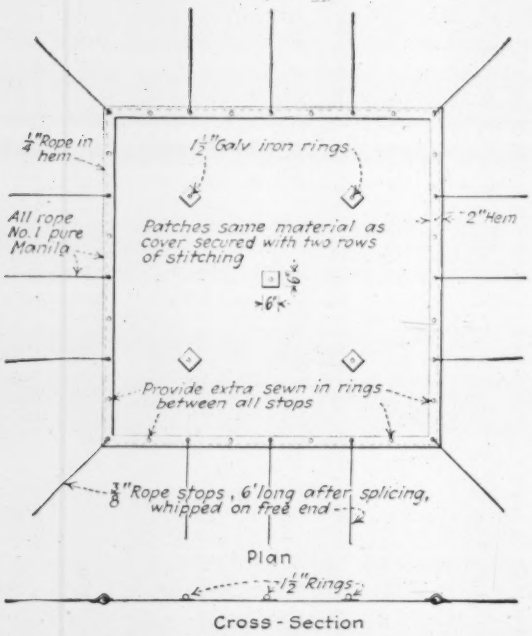

1/4"Rope in hem
1 1/2"Galv iron rings
All rope No.1 pure Manila
Patches same material as cover secured with two rows of stitching
2"Hem
6"
Provide extra sewn in rings between all stops
3/8"Rope stops, 6'long after splicing, whipped on free end
Plan
1 1/2"Rings
Cross-Section

FIG. 39—CURTAIN UNIT FOR WALL PROTECTION

delphia. The shed was two stories and 75x500 ft. The roof was on and the brick side walls and concrete floor had to be placed. Studs 3x6 in. were erected on the guard logs of the pier and were covered with 20-oz. waterproof canvas lapped at the wall tops over onto the shed roof and fastened. Between canvas shell and shed walls was a 4-ft. space in which radiators were set. The heating plant consisted of four sections each carrying about 1,250 ft. of radiation. Each section was connected to an 80-hp. boiler at 5 lb., and all were so valved that heat could be concentrated in any section as wind and cold made it necessary. There was about 1 sq.ft. of radiation to 300 cu.ft. of space. The temperature ranged from 30 to 45 deg. About 3½ tons of coal per day were burned. (J. S. Rogers Co., Philadelphia.)

TABLE IV—TEMPERATURES AT WHICH CONCRETE WAS POURED ON MILL AT BUFFALO

Date	Outside A.M.	Outside P.M.	Inside A.M.	Inside P.M.
January 12	31	24	..	46
January 18	32	13	52	64
January 29	41	23	57	52
February 5	39	21	54	52
February 13	15	8	46	45
February 26	29	11	37	40
March 5	34	30	..	..

As furnishing some temperature records the Russell-Miller mill at Buffalo, N. Y. (The John W. Cowper Co.) is interesting. The inclosed structure was 50x183 ft. and eight stories. A part of the inclosure was brick walls of an old building and part was sheathing on building paper on studding. About 40,000 sq.ft. of radiation in steam coils was provided. At days on which floors were concreted the temperatures are given in Table IV.

A particularly careful study of complete housing was

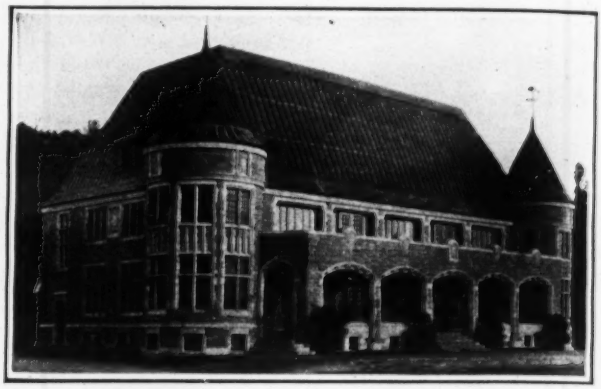


FIG. 40—BUILDING CONSTRUCTED IN TIMBER INCLOSURE (FIG. 42) AT NIAGARA FALLS

made in building the rest house and station, Figs. 40 and 42, at Niagara Falls, Ontario.

The building had to be erected during the winter so as to be ready for the tourists of the spring and summer of 1926. Its location is directly over the Niagara Falls. Thus work was subjected not only to the usual rigors of Canadian winter but the spray from the cataract with the wind in a certain quarter was almost equivalent to immersion. The building was of rock faced stone throughout — the structural design was steel with the usual reinforced concrete floors and concrete fireproofing.

The entire outside scaffolding was erected in skeleton, i.e., the bents of 4x4-in. verticals at 8-ft. centers with the ledgers. The outside of this timbering was then utilized as the framework for inclosing sheeted walls. Whilst this work was being done which afforded a fair measure of protection from the spray, the structural steel was erected. The wood roof of the temporary inclosing shell was then blocked up from the permanent steel roof so that about a 4-ft. space was provided. Extensions were made to include the two towers, the elevator cage shaft, working space and, what was very

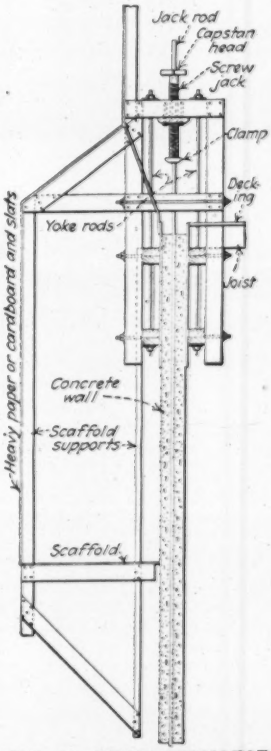


FIG. 41—PROTECTION FOR DRAW FORM CONCRETING

important, hoarding space for materials. It should be borne in mind that as the ice accumulated in December, January and February—this work was more or less isolated. Materials had to be laid in when opportunity offered to last for weeks at a time, and storage space had to be provided.

The 400,000 cu.ft. contents of the temporary shell was heated by a blower heating plant capable of handling 20,000 ft. of air per minute. The vento sections and the fan and housing were rented from one of the Canadian manufacturers for a nominal figure for four months. The high pressure boiler and motor were available from contractor's plant. Temperature was maintained at approximately 60 deg. without any difficulty. The blower was turned on for a 20-min. period not more than five or six times a day during the coldest weather.

The building was completed under this inclosure in every particular, the copper roof being applied in sections by removing and shifting the blocking. Light was obtained from the lantern which was carried along each side, and as short days and accumulation of ice interfered artificial light was obtained from three 1,000-watt searchlights and the usual small extensions employed in lighting construction work.

The walls and roof of the inclosure were covered with three-ply ready roofing. Ice accumulated from time to time under certain extreme conditions, but never got beyond control as the heat in the temporary inclosure always effected "slides" before the weight became too dangerous.

The labor cost on the temporary inclosure was $2,100. The lumber used, including the scaffold uprights and ledgers—but not including planks, of course, was approximately 75,000 ft. b.m. The salvage was most complete. The sheeting (the hardest item to salvage as a rule) was cleaned and built into panels 3x12 ft. and sent to another operation to be used as reinforced-concrete slab forms. Not over 10 per cent was lost. All the 4x4-in. stuff was salvaged without difficulty and about 50 per cent of the ledgers. A conservative safe allowance for loss in material under unfavorable conditions would be 20 per cent, in this case $650. The loss of roofing material was 100 per cent or $511.60.

The summary cost of the temporary inclosure was:

Labor	$2,100
Lumber	650
Roofing	512
Miscellaneous	300
Total	$3,562

The cost of operating the heating system was:

Cost of setting up and taking down	$179.05
Cost of operation	395.05
Rental charges on blower	400.00
Plant—not including contractor's own equipment of boiler and motor	150.00
Allowance for boiler and motor—coal used—54 tons	418.50
Total	$1,506.60

A total cost of winter protection then was about $5,000 on a $240,000 building. (Pigott-Healy Construction Co., Toronto.)

Draw Form Protection—In concreting grain bins, tanks and similar structures where draw forms are used, fairly simple methods of portection and heating have been developed. Fig. 41 shows an arrangement employed on a number of operations (Horner & Wyatt, Kansas City). A framework covered with tar paper attached to the draw form provides inclosure and a finisher's scaffold as shown. Salamanders set around the scaffold provide heat. A similar arrangement of false framework erected on the working platform attached to the draw form and inclosed by canvas curtains was used in constructing cement storage bins at Akron, N. Y. (The John W. Cowper Co., Buffalo.) Here the forms were heated by two rings of 2-in. steam pipe. Also on the bin bottom inside were set eight oil flame burners. The bins were 60 ft. high and 36 ft. in diameter.

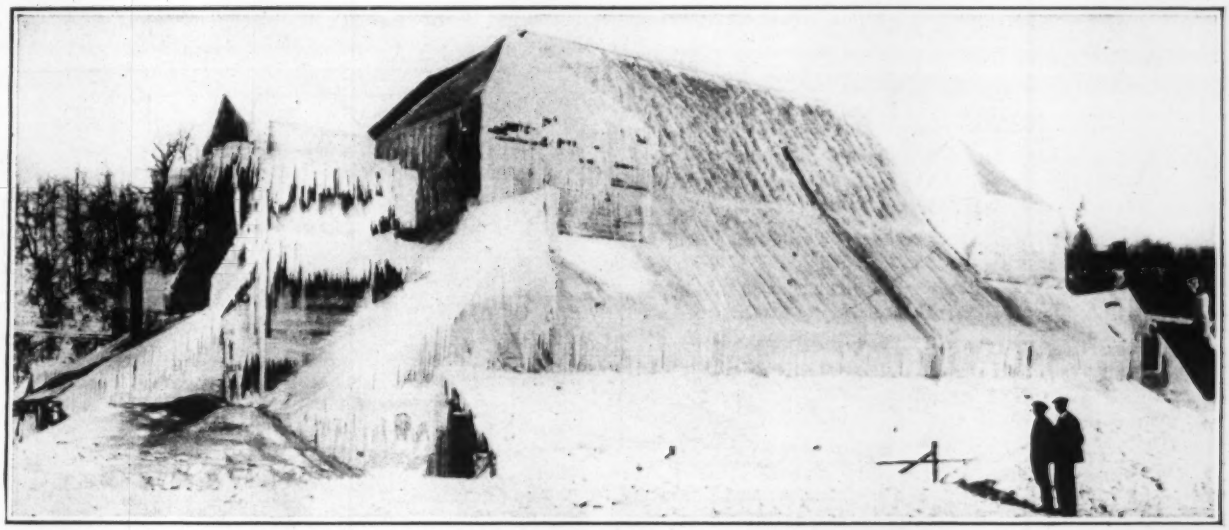


FIG. 42—NIAGARA FALLS BUILDING INCLOSURE IN WINTER

Repairing Pivot of Swing Bridge

In the article on the rapid method of repairing the broken center-casting of the Rock Island Lines swing span at Pekin, Ill., in *Engineering News-Record* of Sept. 22, p. 480, it should have been stated that this method was devised and carried out under the direction of Bert Matheis, chief bridge inspector, with the approval of I. L. Simmons, bridge engineer, and C. A. Morse, chief engineer, of the Chicago, Rock Island & Pacific Ry. System.

Civic Committee Studies Needs Attending Major Disasters

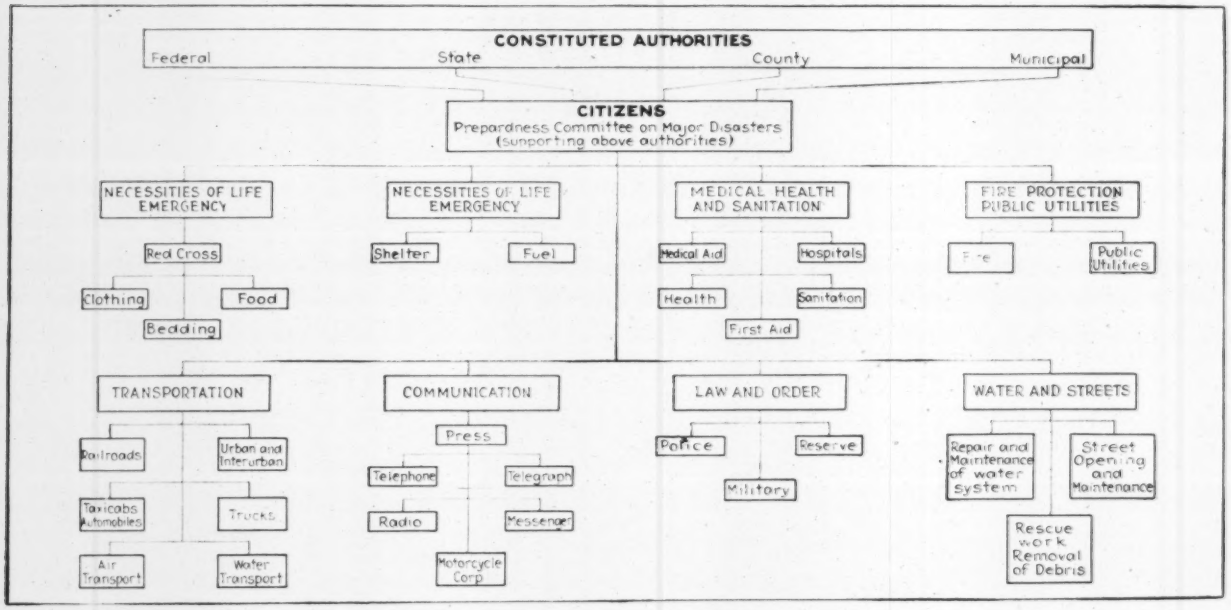
Data of Value in Emergencies Assembled, Rechecked Every 90 Days—Plans for Relief Work if Los Angeles Suffers Disaster

AN ORGANIZATION has been formed in Los Angeles to carry on relief work in case of any great catastrophe due to such natural causes as flood, fire, tornado or earthquake. This organization recognizes that there are contingencies overlooked in our ordinary plan of government and of civic management that may call for special measures to provide for the safety of society. Taking preparedness as its watchword the committee has assembled data and worked out a plan of operation so that in the emergency of any great calamity, forces organized expressly for relief work could begin to function immediately. Although the plan has been developed solely with a view to facilities and natural conditions of Los Angeles, the fundamentals involved are of interest to other cities and essentials of the committee organization are given in the following abstract. This was taken from a paper read by R. J. Scott, chief engineer, Los Angeles Fire Department, before the recent convention of the International Association of Fire Chiefs at Portland, Ore.

The primary object of the comprehensive preparedness program was to develop a plan of procedure that would make it possible to preserve order, supply food and shelter, and afford protection in an adequate manner to the citizens of the community even in the event of the worst catastrophe that could be imagined. With this purpose, the functions of federal, state, county and municipal authorities were centered in one body, known as the Preparedness Committee on Major Disasters, from which radiate subcommittees, each in charge of a chairman selected with a view to his ability to manage the work in his department. These subcommittees with subdivisions are shown in the diagram.

The first subdivision of activity, i.e., Necessities of Life, involved work of such magnitude that it was found best to subdivide it into two committees, one dealing with shelter and fuel and the other with food, clothing and bedding, this second committee being under the direction of the American Red Cross. The work assigned to these committees, perhaps more than any other, increases in proportion to the population to be provided for, and it is to be remembered that in this case the number of people involved exceeds 1,250,000.

Duties of this committee include the location of sources of supply of clothing, bedding and food from all accessible points both within and outside the city, the investigation and listing of transportation facilities for emergency movement of such supplies, provision for quick removal of supplies to places of greater safety



ORGANIZATION CHART FOR A PREPAREDNESS COMMITTEE

when necessary and the listing of information as to the facilities of nearby factories for furnishing clothing on short notice. Stocks on hand and manufacturing capacities are listed for all important sources of food and clothing.

The city has been divided into 14 districts with respect to facilities for shelter, a suitable assembly place being provided in each district. These points were determined with the regard to emergency water supply, health and sanitation features, freedom from exposure, communication by thoroughfares, telephone and telegraph. In this connection there is co-operation with firms manufacturing tents and awnings, portable houses and those dealing generally in lumber and building materials. Facilities for transportation to these areas as well as for furnishing fuel have been taken into account.

Men of the medical and surgical professions have been organized under the Committee on Health and Sanita-

tion. Hospitals within the city and nearby have been investigated, their maximum emergency capacity ascertained and an army of nurses listed for emergency service on short notice. All sources of supply of medicines and drugs as well as all apparatus and materials made use of by the medical profession have been located and charted with due regard to the protection and transportation of these supplies under emergent conditions.

The Transportation Committee's duties include the listing of equipment on steam and electric railroads, taxicabs, motor buses, trucks, available airplanes and pilots, as well as the location of airports and the time of arrival and departure of steamships.

The Law and Order Committee correlates the various agents of municipal, county and federal police forces. In this there has been effective co-operation with the army and navy officials stationed at Los Angeles who have, with the sanction of their principals, placed government equipment and men at the disposal of local authorities in the event of any great catastrophe in so far as government regulations will allow.

The Committee on Water and Streets is charged with the responsibility of providing an emergency water supply if necessary and with the repair and maintenance of the water system which includes keeping readily available all maps and charts of the lines of water distribution, important mains and the location of all valves—information that is too often in the hands of a few men and perhaps not available in an emergency. Provision is also made for clearing débris from streets and keeping them open for traffic movement.

The work on communication covers the listing of all recognized agencies such as telephone, telegraph, radio, messengers, and motor vehicles including motorcycles. Facilities have been furnished by the Telephone Company for connection on short notice to all of the 14 segregation areas referred to and these connections can be made available within a few hours.

The Fire Protection and Public Utilities Committee has made perhaps the most extensive accumulation of maps and charts and lists of facilities of any of the committees. In addition to detailed maps of all utility services, this committee has lists of apparatus, equipment and men that may be secured from outside the city, lists of the key men in all public utility corporations with segregations of their various lines of knowledge and activities, and lists of various agencies within a radius of 150 miles that have agreed to render assistance.

All statistical information, maps, charts and other data compiled by all the committees are kept on file in fireproof vaults in three places in the city; one of these being the fire alarm headquarters in Westlake Park which is centrally located and, due to its location within a public park, will always remain free from fire exposure. Although all chief officers of the committee are in possession of general information as to the contents of the vault, it is kept locked and the only key is in the hands of the chief engineer of the Fire Department. In the event of any emergency the lock is to be forced. This is considered necessary because a great deal of the information collected is of a strictly confidential nature. The committee is pledged never to make use of the information except in the event of some great public emergency. Every 90 days, with the assistance of the corporations involved, all maps and data are gone over and corrected in order to make sure that the information contained will never be out of date.

Cahuenga Pass Arch Retaining Wall Continues Slipping

Highway Structure at Hollywood Continued to Move After Being Relieved of All Load by Fill

By Fred A. Noetzli
Consulting Engineer, Los Angeles, Calif.

THE MULTIPLE-ARCH retaining wall on the highway through Cahuenga Pass at Hollywood, Calif., has continued to move despite the fact that it has been relieved of practically its entire load by an earth embankment on the under side that completely fills the space beneath the arches and rises above the top of the wall. This bears out previous observations that the original movement was not due to excessive soil pressure under the spread footings of the buttresses but resulted from a slip of the foundation material as a whole. For description of the wall and the history of the slip see *Engineering News-Record*, Jan 27, 1927, p. 146.

The wall is 450 ft. long, about 60 ft. high and consists of 15 arches supported by buttresses spaced 30 ft. on centers. It was built during the winter and spring of 1925 for retaining the roadway embankment where a limited right-of-way width made it impracticable to attain the desired width of roadway with an ordinary fill. Some of the buttresses are founded on rock, but under the central portion of the structure the rock was 40 ft. below the ground surface and here the buttresses were carried down only 20 ft., being provided at this depth with reinforced-concrete spread footings designed for a maximum foundation pressure of 4 tons per square foot.

In these buttresses not founded on rock a downward and outward movement was noted soon after the completion of the wall and before the backfill on the uphill side was sufficient to contribute materially to the pressure on the foundation. This movement, which continued at a rate of approximately ½ in. per month for more than a year, included the wall, the rear fill and the front embankment all moving in a body. In July, 1927, the maximum dislocation of the top of the wall was approximately 15 in. downward and 17 in. outward.

No such movement could have been due to the compression of the soil under the spread footings, especially after the load had been taken off the wall by the placing of the front embankment which was built up on the downhill side of the wall and was carried to the top of the structure so as to relieve it of practically all load. In its function of widening the roadway this fill now covers the entire wall.

The consensus of opinion of engineers familiar with the situation is that the movement of the wall was mainly due to slippage of the foundation material as a whole on the steeply sloping bedrock, which lies about 40 ft. below the ground surface. The limited right-of-way made it impracticable to carry any foundation down to bedrock and it is believed that any other type of retaining wall founded on the overlying strata would have been dislocated by the slipping in the same way.

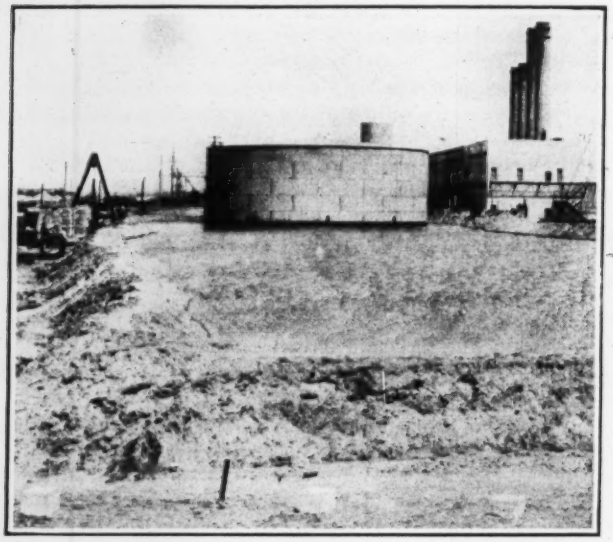
The wall was built by force account by the city of Los Angeles under the direction of D. L. Reaburn, construction engineer. John C. Shaw is city engineer and R. H. Rook is inspector of public works, under whose direction the movements of the wall were measured.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Heavy Steel Oil Tanks Moved 1,000 Ft. in Artificial Canal

NECESSITY for the increase in the steam plant capacity of the Southern California Edison Co., at Long Beach, Calif., required the relocation of two steel fuel oil tanks each having a capacity of about 1,300,000 gal. It was necessary to move these tanks about 1,000



LARGE STEEL OIL TANK BEING FLOATED IN ARTIFICIAL CHANNEL FROM OLD TO NEW POSITION

ft. over a sandy, almost level plain. The tanks were of the five-ring type, 86 ft. in diameter, 30 ft. high and weighing 248,000 lb. Bracing necessary to strengthen them during moving weighed 77,000 lb., making a total weight of each tank of 335,000 lb. In addition to the tanks, concrete dikes which had been built around the tanks of an approximate lineal measurement of 1,300 ft. and weight of 4,000,000 lb. had to be moved.

In order to move the tanks, engineers of Stone & Webster who had the moving job, constructed two dikes about 4 ft. high and 100 ft. apart, extending from the old to the new location of the tanks. The space between these dikes was filled with water to a depth of about 20 in., and the tanks were floated in this artificial pond to their new location. By drawing off the water, they were gently settled on their new foundations, which had been prepared before the pond was filled.

To move the dikes, sections of the wall were cut into pieces weighing approximately 70 tons each. Hydraulic jacks of 70-ton capacity built on the job, were used to raise and lower the sections. After the walls had been cut in the proper lengths, the cribbing was installed on both sides of the wall. Three 8-in. I-beams, 10 ft. long, were necessary to strengthen the 24x24-in. fir cribbing timbers. After the cribbing had been placed, hydraulic jacks were installed and operated simultaneously by being connected in parallel to an air-driven hydraulic pump. As the beams rose, they were followed with blocking, and a small davit and tackle at the ends of the beams carried 12x12-in. blocks until they could be slipped in place. After a lift of 5½ ft., these blocks were held in this position until excavation could be made under the section of concrete to permit laying a railroad track. The concrete section was then lowered onto a steel standard-gage flat car and moved to its new position.

Parts of the wall, owing to the presence of other structures, were cut into 20-ft. lengths and lifted onto the flat car by an A-frame, steel rope blocks being used in conjunction with an 8x12-in. double-drum hoist. The walls were transported to their new location and placed in final position as above described.

The material from which this article was written was taken from the August issue of the Stone & Webster *Journal*.

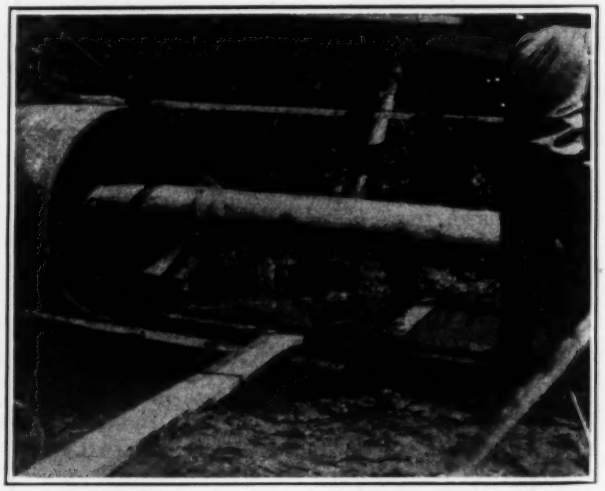
Bypassing Heavy Flow While Connecting Cast-Iron and Concrete Sewer

By J. W. Nemoyer
Resident Engineer, Pearse, Greeley & Hansen, Chicago

IN THE construction of a 48-in. monolithic concrete sewer at the North Chicago sewage treatment plant of the North Shore Sanitary District, Waukegan, Ill., it was necessary to make a connection to a 48-in. cast-iron pipe sewer having a flow at that time of 4 sec.-ft., the connection being made at the end of a short-radius curve.

The customary sand bag dam and flume pipe method of handling the water during the connection would have been quite difficult due to the high velocity of the flow in the cast-iron pipe, so the following plan was devised:

A funnel was made up with sheet iron which was 48 in. in diameter at one end tapering to 12 in. with a 16-ft.



SHEET-IRON FUNNEL BYPASSES SEWAGE FLOW

length of 12-in. flume pipe attached. The funnel was crowded back into the mouth of the 48-in. cast-iron sewer pipe and calked with oakum. A watertight job was obtained easily and during the pouring of the connection

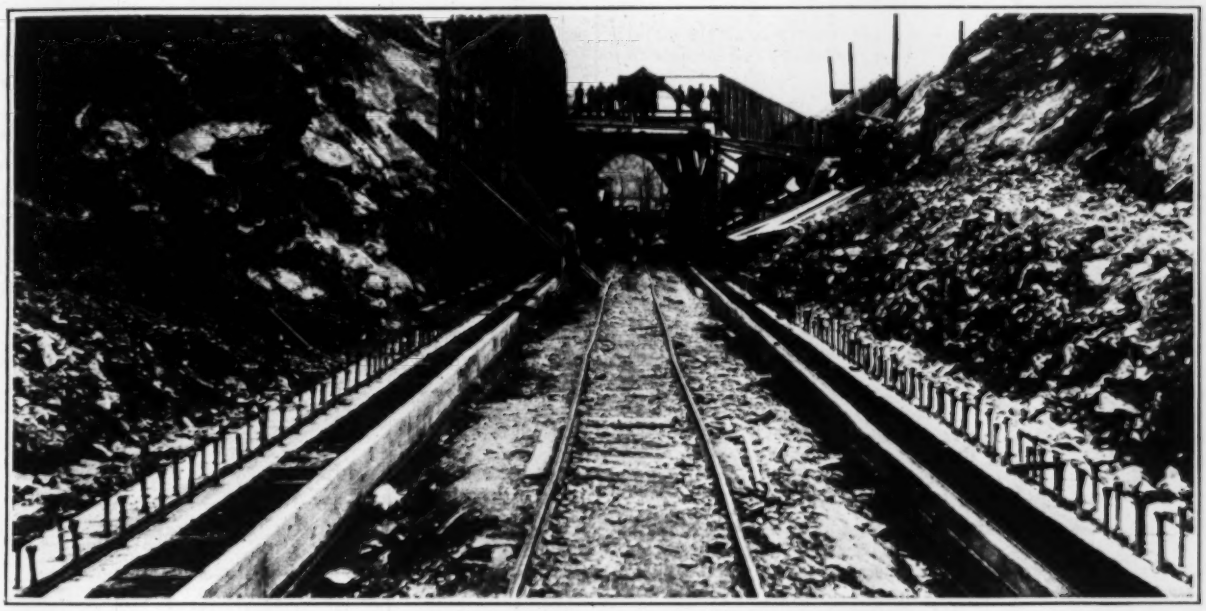
no trouble was experienced through the dribbling of water, which is usual with the sand-bag dam method.

The total cost of handling the water, including the cost of the funnel and flume pipe which was made up in a tin shop, was approximately $45. The idea was conceived by Chas. A. Reeder, superintendent for the Johnson Construction Co. The writer is resident engineer for Pearse, Greeley & Hansen of Chicago.

Gutter Construction in the Moffat Tunnel

WITH a view to avoiding difficulties with clogging of buried gutters in the Moffat tunnel, provision is being made in the lining of that bore for concrete gutters covered by short pieces of plank placed transversely which makes the gutters readily accessible at any point.

This feature of the construction is shown in the accompanying picture which also shows how the sills are set for wall and arch concrete portions of the covered approach at the East portal. The reinforcing projecting to form bond with the wall to be poured above the sills will be recognized as old drill steel.



APPROACH TO MOFFAT TUNNEL AT EAST PORTAL
View taken before forms were placed for walls and arch. Sills and gutters completed.

Contractors and Safety Measures on Construction Work

OF direct interest to contractors was a paper on "Protecting the Public," read at the construction session of the Safety Congress, held recently in Chicago, explaining the necessity of providing all construction operations with protection for the public. Following is an abstract of this paper, which was presented by S. Langner, industrial engineer of the United States Fidelity & Guarantee Co., Chicago.

By protecting the public the contractor protects himself. Investigating accidents and looking after injured persons takes valuable time of foremen and superintendents. The insurance company pays the doctors and lawyers, but the contractor pays his men and contributes largely to the expense of gathering legal evidence. Accident costs not covered by the insurance policy are not usually considered, but they may amount to more than the losses covered by insurance. Many accidents and near-accidents result in no cost to the insurance company, but interrupt the work schedule and make the contractor's employees lose time. Safety measures will eliminate a majority of these cases. Further, in protecting the public the employees also are protected. The most complete protection would result from excluding the public entirely. Streets should be closed where practicable. In some cities, hazardous operations such as hoisting heavy materials or blasting work in business districts are carried on at night. As this is not practicable in most cases it is necessary to analyze hazards and eliminate them whenever possible.

Children contribute to the largest portion of public liability cases. In the child's mind a construction job is a good playground. A child playing in a sand pile near an open manhole fell into the manhole and fractured his skull. A boy fell into an unprotected mortar box, and was burned so severely as to be permanently injured. On one of our risks, children were allowed to play around during working hours; a child walked by a concrete mixer and had his skull fractured by the descending hopper. Children are continually being hurt while playing in piles of sand, brick, stone and other material. If they are allowed to take away wood, it should be placed where they will not be exposed to hazards. The job should be isolated as far as possible by fences and railings, and employees should be educated to the extent of discouraging their friendly relations with children around the premises.

Probably the most common cause of serious accidents to the public, resulting from construction operations, is that of falling planks, tiles, bricks, tools and hot rivets. We have a case where wind blew a plank from the top of a building which was so near completion that the sidewalk canopy had been removed. The plank hit the sidewalk and on the rebound struck a woman and broke her hip. Tools and material should never be left in a position where vibration or wind would cause them to fall. Hot rivets should always be thrown toward the center of the building. Extreme care should be taken in constructing staging and hoists. Trash chutes should be located so that the openings will be isolated. Mechanical equipment should be given frequent rigid inspections. Derricks, engines and cables should not be used to the point where they fall mechanically.

Every man connected with the design of hoistways, stag-

ings, landings, runways or canopies should have a fundamental knowledge of the strength of material. The man on the job who designates work for the different apparatus should be familiar with the safety limits of the apparatus. Superintendents and foremen should be equipped with charts and tables showing the safe loads of the different mechanical equipment on the job. They should be educated to watch for conditions which might result in injury to the public.

Many causes contribute to the large number of cases of persons falling. Walkways should be kept in repair and there should be no holes or loose boards. Leaky water lines in winter result in ice-coated walkways. These conditions invite groundless as well as justified cases of public liability. All protruding obstructions should be well marked. Loose material, tools or equipment should not be left in temporary sidewalks or walkways. Wherever railings are used they should be strong enough to be more than a guide. We had a case where a street had been closed to traffic and the sewer trench was guarded by means of planks laid across small piles of brick. While attempting to board a street car, a woman was pushed against one of the loose planks and fell into the trench. A lawsuit resulted and she collected damages. There are many hazardous conditions around a job which can be remedied by the night watchman. He could repair holes and loose planks in the walkways and straighten out protruding objects.

Construction operations invite trespassing. There is no reason why there should not be a "No Trespassing" sign on every construction job. Superintendents and foremen should know when there is a stranger on the job, and instead of ignoring him should try to ascertain as soon as possible his business and if he has none send him away. We have a great many accidents occurring from blasting, premature explosions, overloading canopies, cavings, nails and glass and hoisting heavy material. The case of protruding nails should be emphasized. It is a common hazard, and often causes a very serious condition, such as infection, which may result in amputation or even death. It is a simple matter to eliminate these nuisances if given attention. The contractor is seldom held responsible for motor vehicle collisions caused by blind corners created by storing construction equipment and material in the street. However, he is morally responsible unless he puts up proper signs, warning drivers of the condition. Material which is protruding into the street should be marked and well lighted at night.

Education is the fundamental solution of these problems. There are three principal groups, each of which must be educated in a different way, and each must be given a good reason why it should adopt safety measures. The first group is made up of architects, engineers, contractors and those officials responsible for the methods used in building. The contractor must be made to realize his responsibility to the public and his duty to himself. He can be reached through his trade journal, through his association with other contractors and through sad experiences, which are bound to come to him and others if they do not heed the call of safety. The second group is the public, which is far more difficult to educate as to the fact that construction operations are hazardous. We must advertise and we must give safety publicity at every opportunity. Safety should be advertised with the purpose of having it voluntarily adopted and not with the idea of inflicting it against the will.

The third group, the employees, must be made to realize that an important part of their job consists in regard for the public, their fellow employees and their own safety. The most advantageous time to impress these men is when they are applying for work. If on being questioned as to their attitude toward safety, they indicate favorable reactions, they will have no complaint when criticized for their carelessness when on the job, and it will be easier to organize them for safety meetings. It should be emphasized that a careless employee is a liability rather than an asset. Every employee should be made to prove that he is a safe worker, and the unsafe worker made to learn that he is not wanted until he has learned that safety is part of his job. To make a job safe, it is necessary to have men who realize the importance of safety.

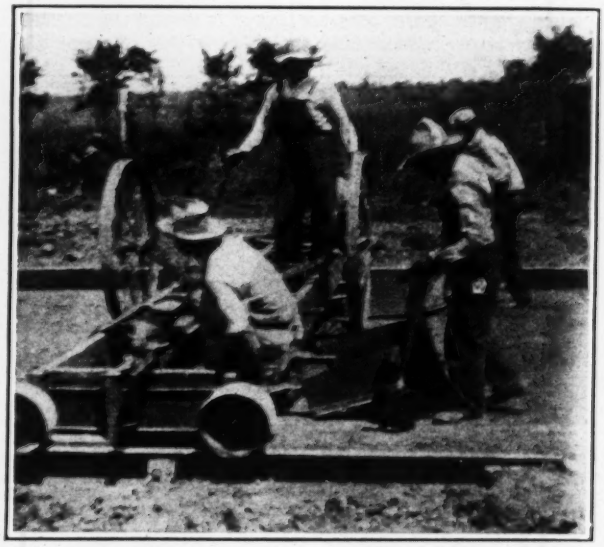
From Job and Office

Hints That Cut Cost and Time

Scraper on Subgrader Collects Plowings Into Small Piles

By J. L. Harrison
Bureau of Public Roads, Washington, D. C.

As ordinarily operated the subgrader leaves two ridges of dirt back of it as it is pulled down the forms for the purpose of cutting the subgrade to exact cross-section. These the laborers throw out with their shovels but as the ridges are small, considerable



DEVICE FOR COLLECTING SURPLUS SUBGRADE EARTH

time is lost in getting enough dirt for a shovelful and, perhaps of more importance, the work is apt not to be well done—too much being taken off in some places if the ground is at all soft, and not enough in other places.

The device shown is a bottomless pan which collects the surplus earth until the bowl is full. The pan or sweep is hinged so that a laborer can raise it and drop the load, thus leaving the cuttings in piles instead of in a couple of windrows—a more convenient condition for rapid accurate work.

Concrete Box Built With Paving Base Obviates Expensive Storm Sewer

By C. J. McNamara
Paving Engineer, North Platte, Neb.

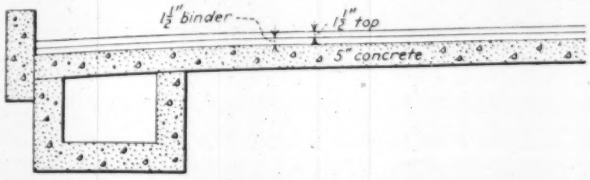
In cities where the grade is flat and the groundwater is close to the surface the problem of caring for storm water is a difficult one. In the city of North Platte, Neb., this problem was met successfully in the manner herein indicated. The city is located on a level strip of land between the North Platte and South Platte Rivers about 3 miles west of their confluence. The ground has a slope eastward of about 7 ft. to the mile and slightly at an angle with the east and west streets

From Job and Office

For Contractor and Engineer

so that the grade on the streets averages about 1¼ in. to 100 ft. Ground-water is close to the surface so that all water and gas mains and sanitary sewers are laid within 4 ft. of the top of the ground.

Construction of a storm sewer under these conditions would be very expensive, so, during a comparatively



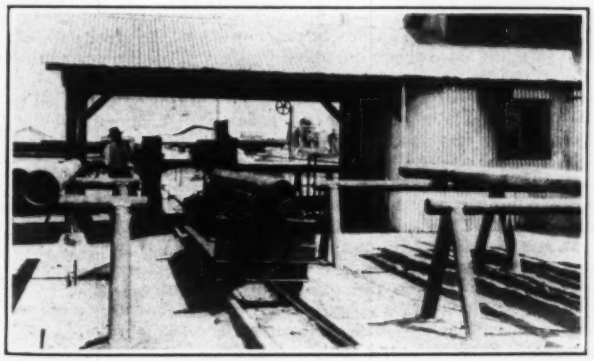
SECTION OF PAVEMENT SHOWING STORM WATER BOX

recent paving program, storm-water was cared for by constructing under the paving near the curb line on the east and west streets a concrete box, shown herewith in relation to the pavement, varying in size as required.

The cost of this concrete box was considered as a part of the street improvement and was charged to the property owners.

Rotating Chains Effectively Clean Pipe in Oil Field Service

LARGE quantities of used pipe and pipe casing of various sizes are reconditioned in the equipment yards of the Standard Oil Co. near Bakersfield, Calif., before being stocked for further use. One of the reconditioning processes is the cleaning off of the remains of protective coatings or rust, scale and other extraneous material that adheres to the pipe exterior. This is done with a home-made device consisting chiefly of a belt-driven disk to whose face a number of short pieces of chain are firmly attached by one end. When the disk is rotated these chains stand out like spokes of a wheel, projecting beyond the edge of the disk so that the sur-



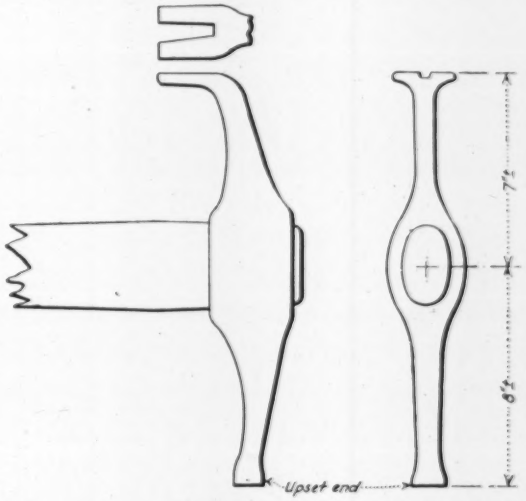
PIPE-CLEANING MACHINE WITH CAR IN FOREGROUND

face of a pipe that comes within reach of the chains is tapped by a rapid succession of light hammer blows.

The pipe section to be cleaned is laid on a car carrying a roller device so arranged that the pipe can be easily rotated by hand as the car moves to and fro within reach of the chains. With this device in operation it is only necessary to move the pipe slowly along in front of the cleaner and at the same time rotate the pipe section slowly by hand. The duration of the treatment is varied to suit the condition of the pipe. Trestles at convenient height on one side of the cleaning machine facilitate the handling of large quantities of pipe.

The "Pickhammer," a Home-made Hybrid Useful on Light Track Work

The lowly pick, usually in evidence on every construction job, can be reshaped in the blacksmith's shop into a tool that is very useful for driving and pulling light spikes of the size used on industrial railroad track. The reshaped tool, for which the name "Pickhammer" has



CHARACTERISTIC FEATURES OF THE "PICKHAMMER"

been suggested, was used in laying and relaying track for concrete cars at the Grizzly Creek diversion dam now being built in California for the Feather River Power Co.

The pickhammer can be made from used picks quite as well as from new ones provided the points have not been worn down too far. In order to avoid exceeding the strength limit of the handle it is undesirable to make the width of the V in the claw very large; keeping the size small discourages its use for pulling standard size railroad spikes or for other heavy uses.

Job and Office Notes

NEW-TYPE HYDRAULIC THRUST-BORING APPARATUS WAS USED in driving a drain under an embrankment of the Southern Ry. (England). In the sheeted thrust pit was installed the main apparatus, consisting of a pair of hydraulic cylinders with piston rods carrying a crosshead to which is attached the 6-in. pilot or boring bar. At the end of each stroke, the bar is detached from the crosshead, which is then run back to allow another length of bar or pipe to be coupled up with a screw joint. When the pilot bar reaches the receiving pit on the other side of the bank, an enlarging head is attached and is pulled back through the bored hole by the crosshead, the steel drain pipes being attached to this head and coupled together to be drawn in as the work proceeds.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Boston Intra-City Toll Bridge Project

Sir—I note with much interest the editorial on p. 533 of your issue of Oct. 6, entitled "City Toll Bridges." Your editorial commences "A new and strange note is sounded by some residents of New York who propose to build a toll bridge across the East River. . . . The project is the first in many decades—in modern times, it may fairly be said—which suggests erecting a toll barrier to free traffic movement within a city." In Boston, such a project does not "sound a new and strange note," for the subject of a toll bridge or tunnel within that city was before the Massachusetts legislature in 1921, 1925, 1926, and 1927, and will be again before it in 1928.

The portion of the city known as East Boston is separated from the northeasterly side of the city proper by a section of Boston inner harbor. It has been a part of the city of Boston since early in the seventeenth century. A bridge connecting these two portions of the city has been the subject of consideration for over a half century, and a toll bridge or tunnel was definitely recommended and has been the subject of various reports to the state legislature. In response to a resolve of the legislature in 1920, a joint board consisting of the Division of Waterways and Public Lands of the Department of Public Works and the Transit Department of the city submitted a detailed report and estimates of a traffic tunnel with suggested legislation providing for the collection of tolls. The legislature of 1925 directed the Division of Metropolitan Planning of the commonwealth to report as to the transportation facilities between Boston and East Boston, and the division recommended definitely that any bridge or tunnel should be a toll bridge or tunnel, and drafted legislation which would permit such a bridge or tunnel to be built by a private corporation with authority to collect tolls.

Private capital showed a strong interest in the project, and a bill was passed by the legislature in 1926 for the construction of a toll bridge or tunnel by a private corporation. This bill was vetoed by the governor, not because he was opposed to a bridge or tunnel but because he felt that in many details the bill as drafted did not adequately protect the public interests and because he was fearful that the high cost of private capital would result in excessive tolls.

In view of the feeling of the governor and others that some means should be found whereby the bridge or tunnel could be built by the use of public funds rather than private capital, thereby reducing the fixed charges, this division submitted a plan to the legislature in 1927 by which the structure could be constructed by public funds but still be subject to tolls for its use. In suggesting this legislation, the division strongly advocated that any securities issued through any public authority should be so conditioned as to render the discontinuance of tolls during the life of the bonds an impossibility. Private interests also again petitioned for authority to build a bridge or tunnel, but enabling legislation was not passed.

In conclusion, I wish to call your attention to the fact that the location of the bridge or tunnel entirely within the limits of the city of Boston instead of connecting two cities or districts did not affect the consideration of tolls. The legislature evidently thought it fair that the original cost, maintenance and operation of the structure should be borne by the users and not by taxpayers of a city, district or state.

The location of the East Boston structure appears to be not unlike that of the proposed structure over the East River to which you refer, inasmuch as travelers are not compelled to use them if they do not wish to. Other means of reaching the same destinations are available in either situation, viz., by ferries or other bridges. The structure would also be not dissimilar to the suggested New York structure inasmuch as it would be of use to the inhabitants of many other localities than that in which it would be located.

E. H. ROGERS,
Chief Engineer, Division of Metropolitan Planning, Commonwealth of Massachusetts.

Boston, Mass.,
Oct. 10, 1927.

Does Not Favor "Levees Only"

Sir—Referring to your very able and interesting review of the discussion of Flood Control of the Mississippi River at the meeting of the Am. Soc. C. E. at Columbus in *Engineering News-Record* of October 20, p. 636.

You are not quite correct in stating that I favor "Levees Only," though I am strongly of the opinion that they furnish the only adequate method of controlling floods and that reservoirs in the delta are impractical. I do not feel, however, that provisions should necessarily be made in building levees to provide for abnormal floods. I said at Columbus, "In determining the grade line of the top of the levees due consideration should be given to economy in cost of construction.

"It would hardly seem necessary to build levees that will provide for the extreme flood that may possibly occur once in 50 or 100 years. For such unusual floods it may be and probably will be more economical in cost and provide greater safety to build controlled spillways that will take care of the floods above a predetermined elevation. The time of arrival and height of the crest of the flood will be known and can be provided for by the manipulation of the spillways. A comparatively small amount of land would be flooded by these spillways and that for a short time." FRANK B. MALTBY.

Norristown, Pa.
Oct. 23, 1927.

Wood Stave Outfall Sewer Encased with Concrete After Bands Fail

Sir—I have read with interest the letter by Robert P. Anderson on "Replacing Wood Stave Outfall Sewer with Concrete at El Paso" in your issue of Aug. 24, 1927, p. 175, and the reply thereto by H. D. Coale in your issue of Sept. 15, p. 443.

In 1905 the El Cerrito sanitary district laid an outfall sewer about 3,000 ft. in length across a salt marsh east of the city of San Mateo, Calif. The pipe was untreated redwood stave pipe of 18-in. inside diameter, of 1¼-in. staves, spiral banded. At that time and continuously until 1913 the marsh was covered with salt water at high tide and uncovered at low tide. In 1913 the marsh was reclaimed and drained. About 1920 occasional leaks appeared and on uncovering the pipe it was found that while the wood was in perfect condition and showed no signs of deterioration, the steel banding had in many cases been corroded entirely through, permitting the staves to separate.

Repairs were made at the time and were later extended to include the whole pipe line, as follows: A portable cylindrical form was made in two halves of such diameter that when placed around the existing pipe it allowed a 2-in. space between the exterior of the staves and the interior of the form. A section was then excavated around and below the pipe and slightly longer than the form, after which the pipe was encased with 2 in. of concrete. This was originally done only in the weak places but the different repairs were later connected to include the casing of the entire sewer. The nature of this work was such that it could be performed by two men of the street department. It is believed that this work will extend the life of the pipe for at least 20 years more.

The conclusions drawn from this are that wood stave pipe of clear selected redwood or of red cedar is not affected by chemical action of sewage, and if of such diameter that the entire perimeter is moist either from direct contact with the water or of the moist gases, it does not fail from the usual cause of alternate wetting and drying. The weak point is therefore the banding of the staves.

San Francisco, Calif.
Sept. 20, 1927

W. C. HAMMATT,
Consulting Engineer.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Engineering Council Drafts New U. S. Public Works Bill

Plan for Separate Cabinet Position Is Abandoned—Interior Department to Contain Services

WITH the support of Secretary Hoover of the Department of Commerce and of Secretary Work of the Department of the Interior, the American Engineering Council has adopted a new plan of executive reorganization affecting public works. The council, it is announced by its president, Dean Dexter S. Kimball of Cornell University, has recognized political expediency without sacrificing the essential principle involved "in centralizing and placing on a business basis" the public works functions of the federal government.

The proposals of the council have been embodied in a bill to be introduced at the coming session of Congress by Representative Adam M. Wyant of Pennsylvania. The new legislative program has been sanctioned by letter ballot of the Administrative Board of the American Engineering Council, composed of thirty national and local engineering societies, and plans to further this program were made at a two-day meeting of the board in York, Pennsylvania, Oct. 20-21, under the auspices of the York Engineering Society.

New Department Abandoned

The most striking feature of the new engineering policy is the abandonment of the idea of creating a Department of Public Works to replace the Department of the Interior but a major division of public works would be created in the Department of the Interior, and would be directed by an Assistant Secretary of Public Works who shall be an engineer. This division, would embrace all of the federal agencies concerned with public works functions.

In essence, the plan is stated in the report of Executive Secretary Wallace as follows:

> To establish in the Department of the Interior a major division of Public Works wherein would be concentrated all of the agencies of the Federal Government concerned with public works. This includes all of the transfers contained in the Wyant Bill of the last Congress and a few others suggested by the Secretary of the Interior.
>
> There has been omitted from the revised bill any reference as to what the internal organization shall be after the transfers are made, with the exception that the revision specifies there shall be an Assistant

(Continued on p. 690)

Section of Timber Stands Collapses During Football Game at Richmond, Va.

(Special Correspondence)

About 90 persons were injured, some more or less seriously, when a section of the timber bleachers at Richmond, Va., collapsed during a football game between the University of Maryland and V.M.I., Oct. 22.

The failure occurred in a longitudinal girder supporting six benches over a 12 ft. 6-in. span. The girder was composed of four 2x12s spiked together. Examination showed that rot had entered between the planks composing the girder, destroying the fibers except at the surface. Where the 2x12s had come apart in the fall, it was possible to insert the full length of a knife blade with but four or five pounds pressure, although the outer surfaces still appeared sound. Failure originated over a column.

The structure had been inspected by the Building Inspector's office within the week prior to the game, at which time another section was condemned and ordered removed.

Institution of Civil Engineers Awards Medals and Prizes

The Council of The Institution of Civil Engineers has recently made the following awards:

The Howard Quinquennial Prize to Professor W. E. Dalby, M.A.,B.Sc., F.R.S., M.Inst.C.E. in recognition of his researches on the strength and structure of iron and steel. The Indian Premium to Mr. A. W. Stonebridge, M.Inst.C.E.

For selected engineering papers published during the session of 1926-27:

A Telford Gold Medal to Sir E. Owen Williams, K.B.E., B.Sc., M.Inst.C.E. (London); Telford Premiums to Messrs. E. H. Salmon, D.Sc., M.Inst.C.E. (London); R. S. Cole, M.A., Assoc.M.Inst. C.E. (India); H. Mawson, D.Sc., Assoc. M.Inst.C.E. (Liverpool); and A. H. Douglas, M.C., B.A., B.A.I., Assoc.M. Inst.C.E. (London); and a Crampton Prize to Mr. D. McLellan, M.Inst.C.E. (Glasgow.)

For papers read at students' meetings in London or by students before meetings of local associations during the same session:

The James Forrest Medal, the James Prescott Joule Medal and a Miller Prize to Mr. R. F. Legget, B.Eng., Stud.Inst. C.E. (Liverpool); and Miller Prizes to Messrs. A. H. D. Markwick, B.Sc., Stud. Inst.C.E. (Ferrybridge); F. C. Jordan, B.Sc., B.Sc.Tech., Stud.Inst.C.E. (London); L. G. B. Rock, Stud.Inst.C.E. (London); C. J. Chaplin, B.Sc., Stud. Inst.C.E. (Wakefield); and F. V. Cornish, B.Sc., Stud.Inst.C.E. (Tankerton.)

Public Health Is Discussed At Cincinnati

Engineering Section Holds Well-Attended Sessions During 56th Annual Meeting of A.P.H.A.

(Special Correspondence)

THE 56th annual meeting of the Public Health Association, held at Cincinnati, Oct. 17-21, was better attended in respect to the sessions of the Engineering Section than any previous convention in the last 10 years. Though the general convention had full sessions, the engineering section deliberations are of particular interest here. The present membership of this section is 263, of which 33 were added during the past year. Of these, 103 are Fellows of the association. The new officers of the Public Health Engineering Section are A. E. Gorman, chairman; Stephen DeM. Gage, vice-chairman, and G. W. Putnam, secretary.

The first session of the Engineering Section on the morning of Oct. 18 was devoted primarily to papers on engineering problems in the control of milk supplies. A report of the committee on milk supplies detailed the deficiencies and certain suggested corrections in current design of pasteurization plants and presented a code of requirements based largely on that issued by the U. S. Public Health Service recently. At the same session, H. D. Schmidt, of Nashville, set forth the opportunities a sanitary engineer has in county health work for sanitation education. T. J. Duffield reviewed progress made during the past year in the study of school ventilation. Mechanical and natural window ventilation again came in for a great deal of discussion, but as yet no agreement has been reached as to the details of studying the effect of these opposing methods on the health of the school child or in evaluating their advantages and disadvantages.

Sewage Nomenclature

The report of the committee on standard sewage nomenclature prepared by Kenneth Allen and representing practically the same findings as those presented before a recent meeting of the American Society of Civil Engineers, was read and accepted. This report contains 310 titles and more than 350 definitions. The report of the committee on standards for design, construction, equipment and operation of swimming pools and other public bathing places was the same as that presented last year, except that minor corrections

as to residual chlorine requirements in the pools and a modification in the wording referring to the efficiency of ultra-violet ray disinfection, were made. The report of this committee was approved and its publication requested.

Roadside sanitation was introduced into this session in a paper by R. G. Beckett, which was followed by considerable discussion by the representatives from Ohio, Pennsylvania, Illinois, West Virginia, and Florida. J. H. O'Neill, of the Kentucky State Board of Health, described the relief plant used during and after the Mississippi flood. He emphasized from the engineer's viewpoint the distinct practical advantage of the self-contained county health unit.

At the dinner session of the Engineering Section Wednesday evening problems of increasing membership in the section were reviewed by Abel Wolman; detailed figures on mosquito control were presented by L. E. Jackson as chairman of that committee; successful adoption of the standard chlorine tank valve by members of the Chlorine Institute was announced by A. E. Gorman, chairman of the committee appointed to negotiate these undertakings with the Institute. The report of the committee on refuse collection and disposal contained a brief summary of the progress during the past year and referred particularly to the construction of incinerators by Birmingham, Los Angeles, Buffalo, and to the development of reduction and recovery plants at Indianapolis and Kansas City.

Sewage and Water Treatment

The session on Thursday morning, devoted almost entirely to papers on sewage and water treatment, industrial wastes treatment, and stream pollution control, indicated a definite trend toward more scientific evaluation of stream pollution effects and a policy of the reasonable balancing of conveniences in the uses of streams. It was agreed that the control of stream pollution should reside in a single administrative unit and that the most satisfactory unit was the state board of health.

The report of the committee on sludge disposal contained an interesting analogy between the disposal of sludge and the recovery of garbage. Calculations of the quantity of combustible materials in sewage were presented, indicating a lesser proportion than in the per capita contributions in garbage.

Further papers of interest to engineers were presented at the laboratory and industrial hygiene section sessions, dealing particularly with (1) the effect of minimum amounts of chlorine on bacterial death rates; (2) on protecting the sanitary quality of milk between pasteurization and bottling; (3) on lead poisoning due to lead-conducted water supplies; (4) on bacteriological observations on sludge digestion at different temperatures; (5) on experimental studies of bacterial death rates in polluted waters; and (6) on activities of plankton in polluted waters.

An informal session of the Conference of State Sanitary Engineers was held Oct. 17, relating primarily to the experiences of various states on schools for operators of sewage-treatment plants, the control of stream pollution, co-operative undertakings by state and industry on the study of industrial waste treatment, and a comparison between the policies revolving around these problems in this country with those developed during the past 100 years in England, Germany and Holland.

The Committee of 100 held a public session on Friday morning, Oct. 21, at which time reports of the sub-committees of this group, together with the conclusions and recommendations of the committee itself, were presented. After considerable discussion, the conclusions and recommendations of the committee were adopted and the present committee discontinued. At the same time, a new committee was authorized to investigate further organization details and to report a program of action at another meeting to be held during the annual meeting of the American Society of Civil Engineers in New York City. C. A. Emerson, Jr., was designated as the chairman of this committee to be composed of a representative of the U. S. Public Health Service, representatives of states having established or contemplated local associations and conferences together with officers of such

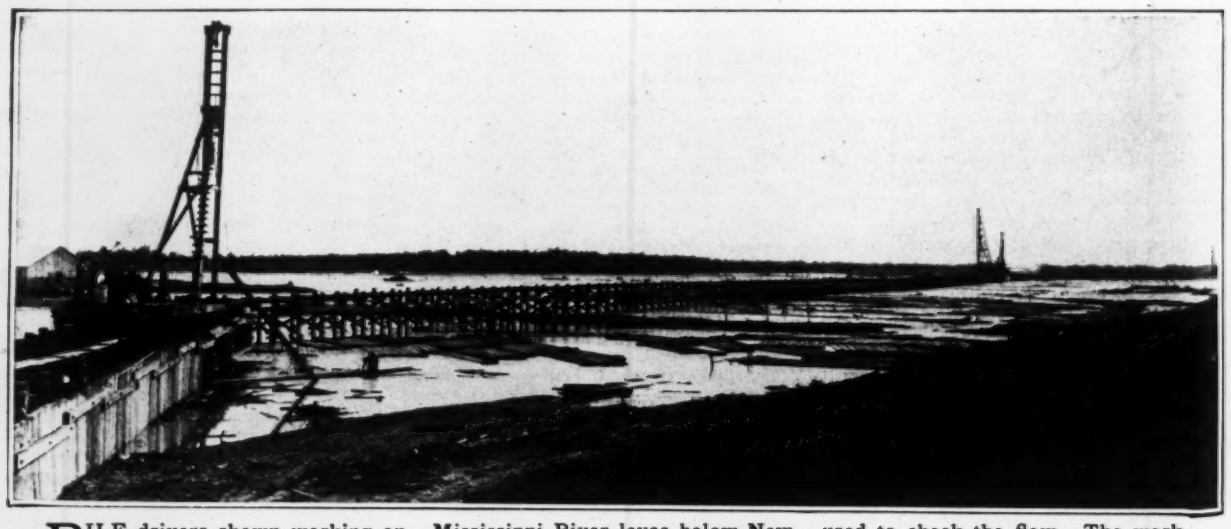
(Continued on p. 690)

Engineering Employees to Seek 35 Per Cent Salary Increase

About 500 members of the Union of Technical Men, Local No. 37, and others employed in New York City engineering departments, met last week to discuss the proposed budgetary increase in salaries for men in engineering positions in the city services. After talks by Dudley P. Babcock, president of the union, Hugh Frayne, organizer of the A.F.L., and Daniel J. Hauer, business agent of the union, a resolution was passed thanking the Board of Estimate for the proposed inclusion of $600,000 for engineering salaries, but asserting that sum to be inadequate. It had been hoped that the Board of Estimate would act on Mayor Walker's suggestion that this amount be doubled.

The Union of Technical Men went on record as having for a definite objective the securing of a 35 per cent increase for all engineering employees, a rate of increase recommended by Thomas C. Murray, civil service examiner.

CLOSING CAERNARVON CREVASSE ON THE MISSISSIPPI



PILE drivers shown working on the 4,000-ft. timber structure built to close the gap cut in the Mississippi River levee below New Orleans last spring. Interlocking sheetpiling of southern pine was used to check the flow. The work of closing the breach was completed in 39 working days.

Twenty Cities and Counties Attend Wisconsin Regional Plan and Zoning Conference

The first annual conference of the Wisconsin City and Regional Planning Association was held in Milwaukee, Oct. 6-8. About 20 cities and counties, all of which are doing considerable planning work were represented. The master highway plan for Milwaukee County, street widening, the legal aspects of highway widening, and the comprehensive zoning for Milwaukee County were high spots in the program. W. F. Cavanaugh, Milwaukee County highway commissioner, asserted that the master highway plan for that county was being laid out on the basis of an automobile census and forecast of registration carried forward to 1950, when it is expected that the city of Milwaukee will have a population of 1,180,000. Under the Wisconsin state law, a county may lay out a master highway plan and establish setback lines to protect the future right-of-way. This is being done and new buildings are being held back to the new street line.

L. D. Tilton, associate of Harland Bartholomew, city planning consultant of St. Louis, emphasized the fact that many things can be done on a street to increase its traffic capacity before widening was undertaken: the installation of traffic control lights, the prohibition of parking either for all time or at specific intervals, and provision for loading bays for motor buses.

In a discussion of legal aspects of highway widening, Clifton Williams, dean of the law school of Marquette University, indicated that the Wisconsin law requires some amendment in order to bring about an ideal situation.

One of the outstanding items was the comprehensive zoning of the whole of Milwaukee County. This is being done by the Milwaukee City and Regional Planning Association under the authority granted by the Wisconsin state law. A zone ordinance for Milwaukee County has been approved by all of the towns in the county and is ready for adoption by the board of supervisors.

New Foundation Co. Branch

Incorporated under an Ontario charter, with a capitalization of $100,000,000, the Foundation and Construction Co. of Ontario, Ltd., has been recently formed to carry on a general contracting business in that province. The new company has grown out of the Foundation Co. of Canada, Ltd., which has been associated with many large construction undertakings in the province. This company, in turn, is part of a world-wide organization of Foundation companies.

Hon. F. H. Phippen, K.C., of Toronto is president of the new company; R. E. Chadwick, M.E.I.C., a former resident of Toronto, and a graduate of the University of Toronto, vice-president.

Coal Age Associate Editor Gets A.B.P. Award

Sydney A. Hale, associate editor of *Coal Age* and managing editor of *Coal Age News*, both McGraw-Hill publications, has been awarded a prize of $500 by the Associated Business Papers for the best editorial written for the year ending June 30, 1927, by a regular member of the staff of an A.B.P. publication. The editorial which won the prize for Mr. Hale was entitled "No More Panaceas" and was printed in *Coal Age*, July 15, 1926. The committee of awards included David Beecroft, (chairman), vice-president, Chilton-Croft Publishing Co.; Dr. Julius Klein, director, Bureau of Foreign and Domestic Commerce, Department of Commerce; W. A. Wolff, former president of the National Industrial Advertising Association; W. M. Richardson of Barrows, Richardson & Alley and chairman of the Business Papers Committee of the American Association of Advertising Agencies; and James W. Brown, publisher of *Editor and Publisher*.

Bridge Applications Approved by War Department

The acting Secretary of War, Col. Hanford MacNider, has approved the following:

1. Application made by the Morgan's Louisiana and Texas R.R. and Steamship Co., for approval of plans of a bridge to be reconstructed over Bayou Courtableau at Washington, Louisiana, under authority of state law.

2. Application made by the Board of Chosen Freeholders, Middlesex County, New Jersey, for approval of plans of a bridge to be reconstructed over the South River at Old Bridge, N. J., under authority of state law.

3. Application made by the county commissioners of Lawrence County, Pennsylvania for approval of the plans of a bridge to be constructed over the Beaver River at Wampum, Pennsylvania, under authority of state law, to replace the existing bridge at that locality.

4. Application made by the Atlantic City R.R. Co. for approval of plans of a bridge to be reconstructed over the Tuckahoe River, one-half mile north of Tuckahoe, N. J., under authority of state law.

5. Application made by the Westchester County Park Commission, Bronxville, New York, for approval of revised plans for a bridge authorized under authority of state law, to be constructed over Annsville Creek (Peekskill Creek) near Peekskill, New York. These revised plans provide for solid fill construction for a length of approximately 725 ft. and pile and trestle construction for a length of approximately 635 ft.

Application made by the Baltimore and Ohio Chicago Terminal R.R. Co. for extension of time of commencement of construction of a bridge across the south branch of the Chicago River about 400 ft. north of west 16th St., Chicago, Ill., as authorized by an instrument dated Oct. 8, 1926, under authority of state law. The date of commencement of construction was specified Oct. 7, 1927, but because of delay in preparation of plans by the railroad company, the Secretary of War has approved a one-year extension.

Welded Railroad Bridge Now Under Construction at Chicopee Falls, Mass.

An arc-welded railroad bridge is under construction at Chicopee Falls, Mass., crossing a power canal on a track connection between the Chicopee Falls branch of the Boston & Maine R.R. and the Westinghouse Electric & Mfg. Co.'s plant. This bridge is a thorough truss span designed for single track, with Cooper's E-50 loading. It has an extreme skew of about 72 deg. and has an overall length of 175 ft., although the span of either truss is only 135 ft.

Whereas an equivalent riveted bridge of the same dimensions and loading would require 120 tons of steel (this estimate based on the riveted design originally made), the welded structure requires only 80 tons. The saving is due mainly to reduction in weight of gussets and other connections, absence of rivet-hole deductions for tension members, and continuity of floor stringers. The contract price reflects a sharp reduction in cost as compared with equivalent riveted construction, and the contractors expect to show a great saving in elapsed time between signing of contract and opening of bridge to traffic. Actual cost data and time required for construction will be made public later.

The steel fabrication and welding are in the hands of the Palmer Steel Co. of Springfield. Tarbell & Leete of Chicopee Falls are now constructing concrete piers and will erect the bridge. The structure will be assembled on one bank and moved bodily into place. The owner is the Westinghouse Electric & Mfg. Co., with A. B. Reynders, works manager of the Springfield works, in charge. The welding, although performed under contract by the Palmer Steel Co., will be supervised by engineers of the Westinghouse company, under the general direction of W. S. Rugg, vice-president in charge of engineering. Gilbert D. Fish is the consulting engineer. B. W. Guppy, engineer of structures of the Boston & Maine R.R., represents the railroad in the operation.

Power Tunnel Contract Let

The British Columbia Electric Railway Co., Ltd., has awarded the contract for boring the Bridge River power tunnel to Pacific Engineers, Ltd., of Vancouver, for $1,249,530. According to an estimate made by President George Kydd, of the B. C. Electric, the job will cost about $2,000,000 when details, not included in the contract, are considered. Work on the 2½-mile bore will start immediately from the Seton Lake end, and on May 15, 1928, from the Bridge River end. The contract calls for completion within 1,000 days, which period will elapse in August, 1930. Unit prices of the successful bidder will be published in an early issue of *Engineering News-Record*.

New Public Works Bill Drafted

(*Continued from p. 687*)

Secretary of Public Works who shall be qualified by experience and training to direct work of such character.

To include organization matter in the bill would unnecessarily add to the difficulties of securing favorable action. If the transfers are made the character of the organization will be a departmental question which can be dealt with at the proper time.

Upon the suggestion of the two secretaries, the provision remains that members of the Engineer Corps, may, upon the request of the Secretary of War and with the approval of the Secretary of the Interior, be temporarily transferred to the Division of Public Works for training and experience.

Centralization of the public works functions of the federal government is contemplated by the following transfers and other changes:

1—From the Department of Agriculture, the Bureau of Public Roads except the agricultural engineering division thereof.

2—From the Department of the Treasury, the Office of the Supervising Architect.

3—From the Department of War, the rivers and harbors improvements, including the Board of Engineers on Rivers and Harbors, and the duties of the Chief of Engineers thereto appertaining; the Mississippi River Commission; the California Débris Commission; and the Alaska Telegraph and Cable System, and all other engineering and construction work of a civil character.

4—The Board of Road Commissioners for Alaska, under the jurisdiction of the Department of War, is hereby abolished; and the authority, powers and duties conferred and imposed by law upon said board shall be held, exercised, and performed by the Secretary of the Interior through such instrumentalities as he may determine, with the approval of the President.

5—The Office of Public Buildings and Public Parks of the National Capital is hereby abolished; and the authority, powers, and duties conferred and imposed by law upon the said office shall be held, exercised, and performed by the Secretary of the Interior through such instrumentalities as he may determine, with the approval of the President.

6—The Inland Waterways Corporation is hereby transferred from the jurisdiction of the War Department to that of the Department of the Interior and the Secretary of the Interior shall have and exercise all the powers and duties now imposed by law upon the Secretary of War in respect to said corporation.

7—The Rock Creek and Potomac Parkway Commission is hereby abolished, and the authorities, powers, and duties conferred and imposed by law upon said Board shall be held, exercised and performed by the Secretary of the Interior through such instrumentalities as he may determine with the approval of the President.

8—The Commission on Fine Arts is hereby transferred to the jurisdiction of the Department of the Interior, and the authorities, powers and duties conferred and imposed by law, executive order, and otherwise, upon the said Commission shall remain with the commission, except that the Secretary of the Interior shall direct the efforts of the commission to conform with the Public Works functions of his Department, with the approval of the President.

Core Studies Being Undertaken at Germantown Dam

A shaft is being sunk in the Germantown dam of the Miami Conservancy District for the purpose of making studies of the core of this dam, which is of the hydraulic fill type. A drill hole will also be made near the shaft.

It is intended to study the nature of the core material as to consolidation, stratification and permeability. The core will be compared with borrow-pit material with a view to estimating the accuracy of computations on the behavior and properties of the core based on knowledge of the borrow-pit material in its original state. Comparisons will be made between samples from drill hole and shaft.

The shaft consists of a concrete casing (internal diameter 5 ft.) cast in 3-ft. sections, which sinks of its own weight as the excavation proceeds.

Samples are being taken in pairs, one horizontal and one vertical in each pair. They are removed in 4-in. pipe, 12 in. long, with a cutting edge at one end and every effort is made to handle them in such a way that the soil in the pipe is not disturbed. The samples are placed in sheet metal containers and sealed with paraffin to prevent loss of moisture.

The laboratory work will be done by Glennon Gilboy under the direction of Dr. Chas. Terzaghi at the soils laboratory of Massachusetts Institute of Technology. A special permeameter has been designed for the permeability tests. The results of the investigation are to be published jointly by the Massachusetts Institute of Technology and the Miami Conservancy District.

Hyatt Made State Engineer of California

Edward Hyatt, Jr., whose appointment as acting state engineer of California was noted in these columns Sept. 20, has been made state engineer of California. Simultaneously a new plan of operation has been adopted for the division of water rights of which Mr. Hyatt was chief and which handled all state engineering matters concerning irrigation, reclamation and water rights, generally. Harold Conkling, principal assistant in the state division of water rights, has been named the chief of the division until legislation can be secured approving the new plan of operation.

Under the new plan there is created a division of water resources under the state department of public works which will take over all functions of the former water rights division. Mr. Hyatt in his capacity as state engineer will head this new division. Mr. Hyatt is a graduate of Stanford University and has been in state employ since 1914, first as an engineer with the Highway Commission, and since 1916 in the division of water rights where he advanced progressively from field engineer to head of the division.

Public Health Association Meets

(*Continued from p. 688*)

associations, and one member of each sub-committee of the Committee of 100. He was delegated to convene his committee to carry out such duties in connection therewith as may result in a program of action to be submitted in January.

The reports of sub-committees, with one exception, indicate the need of an organization based upon a federation of state or sectional associations for the presentation and discussion of papers on sewage and industrial waste research, operating records and abstracts, and for the publication of such material for the benefit of all the members of the various local associations.

Such local organizations are now in existence in 8 states and under consideration in several others. Adequate funds for the suitable publication of a journal are definitely in sight. The actual publishing of the journal could be undertaken by A.P.H.A. which now acts as publishers of Standard Methods of Water Analysis.

Resolutions were passed urging coordination of the public health activities of the federal government and approving the principles of the Ransdell bill relating thereto, favoring the placing of sanitary engineers of the U. S. Public Health Service on the same commissioned status as regular army medical officers, urging co-operation in the construction and operation of swimming pools and public bathing places to conform to the standards set by the engineering section and the state sanitary engineers, and calling public and private attention to the growing need for smoke abatement in cities.

The officers of the Public Health Association are as follows: President, Dr. Herman N. Bundesen, health commissioner of Chicago; first vice-president, George W. Fuller, New York; second vice-president, W. H. Peters, health commissioner of Cincinnati; and third vice-president, James Roberts, health commissioner of Hamilton, Ont. Dr. L. I. Dublin was re-elected treasurer and Homer N. Calver, executive secretary.

Canadian City Adopts City Manager Plan

At a recent election the voters of Lethbridge, Canada, voted overwhelmingly in favor of the council-manager plan of government. A commission form of government has been in vogue for fourteen years. The present charter calls for a mayor who is commissioner of finance at $4,000 per annum, a commissioner of public utilities at $3,500 and a commissioner of public works at $3,500, each elected for three years. This plan of government will be superseded under the proper legislative authority by a government composed of an elective mayor and council of six and an appointive city manager.

Personal Notes

SAMUEL G. PORTER, Calgary, Alberta, Canada, has been appointed head of the Canadian Pacific Ry. Co.'s department of natural resources at Calgary where he has been superintendent of maintenance and operation and then assistant manager. Mr. Porter is a graduate of Baylor University at Waco, Texas, and of Massachusetts Institute of Technology and has served with the U. S. Bureau of Reclamation and in industrial engineering in Colorado.

ELLSWORTH HUNT, city engineer of Kokomo, Ind., has resigned after a year of service. Formerly he was for four years county surveyor of Howard County.

A. W. HILL, of Fort Morgan, Colo., has been appointed county surveyor of Morgan County, Colo., filling the unexpired term of Robert F. Baker. Mr. Baker was forced to resign on account of ill health.

OTTO S. ROEN, formerly city manager of Ontario, Calif., has been appointed city manager of South Pasadena, Calif., succeeding E. A. Stockburger, who has gone to Alhambra, Calif.

W. J. HAGENAH, consulting engineer, Chicago, has been retained by the city of Montreal to represent that municipality in the expropriation proceedings in connection with the taking over of the Montreal Water and Power Company's properties.

J. E. GAGNON, civil engineer, Quebec, has been appointed assistant senior engineer for Quebec district, Department of Public Works. Mr. Gagnon is a graduate of Laval University and is a member of the Professional Engineers' Association of Quebec.

RALPH B. ROBINSON recently went to Chile, S. A., for work on an extensive railroad, topographical and triangulation survey at Maria Elena, for the Anglo-Chilean Consolidated Nitrate Corporation. He had come back to the United States this year after serving with the Rio Blanco Mining Co. near Santiago, Chile. Mr. Robinson is a graduate of the University of Iowa.

MILTON MCCOLM, formerly engineer of the city planning commission of Sioux City, Iowa, and later with the Davidson Realty Co. in that city, has joined the staff of the engineering firm of McCrary, Culley & Carhart with offices in Denver, Colo., and Salt Lake City, Utah.

FREDERICK PALMER, consulting engineer of London, England, who recently made a study of possible terminals for the Hudson Bay Ry. at Fort Churchill and Port Nelson on behalf of the Canadian Government, has returned to England. Mr. Palmer issued a preliminary statement to the Government favoring Fort Churchill before he left. His final report probably will be submitted about the end of this year.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

THE IOWA CONFERENCE ON SEWAGE TREATMENT will hold its ninth annual meeting at the Iowa State College, Ames, Iowa, on Nov. 8 to 10. The program comprises lectures, demonstrations and round-table discussions of everyday problems in the care and operation of sewage works, but it is arranged to have considerable time available for the discussion of the individual problems of those in attendance.

THE NATIONAL MUNICIPAL LEAGUE will hold its 23rd annual meeting Nov. 10 and 11 in New York City. Among the papers to be read of particular interest to engineers are those on special assessments, state supervision of local finances, improving college courses in municipal government, and university training for public service.

THE SAN FRANCISCO SECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS held a regular bimonthly meeting on Oct. 18. In accord with the plan of having five-minute talks on subjects of current engineering interest, J. G. Wright presented very briefly the interesting features of the Sears Point toll road. The main technical program consisted of a symposium on "The Measurement of Flow of Water in Closed Conduit." Roy Wilkins described results obtained with the Allen salt velocity method and showed oscillograph records of water measurement studies. Fred C. Scobey discussed the subject from the aniline dye standpoint, and Arthur L. Collins described some improved Pitot tube methods of measurement.

THE NEW JERSEY SOCIETY OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS, Essex and Union County chapters, will hold a joint dinner and business session Wednesday evening Nov. 2 at 6:30 p.m., at the north Y.M.C.A. Halsey Street, Newark. Engineers and their guests, whether members of the society or not, are invited to attend. H. W. Heilman, 313 Courthouse Building, Newark, is secretary of the Essex County chapter, and Trevor J. Powell, Elizabeth, secretary of the Union County chapter.

THE WESTERN SOCIETY OF ENGINEERS will have a paper on "The Carquinez Straits Bridge," by C. F. Goodrich, designing engineer, on Nov. 7. The question of "Air Rights, their Possibilities and their Limitations" was discussed by Joshua D'Esposito, consulting engineer, on Oct. 10, and "Building the New Lock at Lockport, Ill.," was described Oct. 24 by Walter M. Smith, chief designing engineer for the Illinois Division of Waterways. For a dinner meeting on Oct. 26, in conjunction with other engineering societies in observance of Management Week, the program included "The Use of the Business Cycle in Business Management," by Franklyn Hobbs, Central Trust Co., Chicago, and "Safeguarding Net Profits, Management's Principal Function," by C. E. Knoeppe, Waste Eliminatory Co.

Obituary

THOMAS H. MCMINN, a former assistant secretary of the American Society of Civil Engineers, died recently at his home in Upper Darby, Pa. Mr. McMinn formerly was engaged in the construction of the water-works of Toronto, Ont., making surveys, plans, specifications and estimates, and serving as resident engineer. Later he was connected with the late Rudolph Hering, of New York City. More recently, before his retirement, he had been in engineering work at Bridgeport, Conn.

GEORGE W. MCCARTER, for many years city engineer of Warsaw, Ind., and developer of the plans which provided for most of the paving in that city, was killed in an automobile accident near that city recently. He was 67 years old.

PERLEY F. WALKER, dean of the School of Engineering and Architecture, University of Kansas, Lawrence, committed suicide Oct. 17 in his office. Dean Walker was born in Maine 52 years ago and graduated from the University of Maine in 1896; later he obtained a master's degree from Cornell University. He went to the University of Kansas in 1905 and ten years later was appointed head of the school of engineering; when that school was combined with the school of architecture he continued as dean of the combined school. Mr. Walker acted as consulting engineer on many gas and oil field matters and collaborated in making a report on industrial coal. He was the author of a book, "Management Engineering," and of many papers published in various journals.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Concrete Road Yardage

For September the square yardage included in concrete pavement contract awards according to the Portland Cement Association was 6,872,398 for roads; 4,365,135 for streets; and 343,270 for alleys; or a total for the month of 11,580,803 sy.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,656,118	1,504,059	75,352	4,235,529
Feb....	2,336,031	1,935,262	119,382	4,390,675
March.	5,134,974	3,866,102	298,667	9,299,743
April...	10,264,336	4,931,954	285,924	15,482,214
May....	8,234,755	5,601,627	397,220	14,233,602
June...	8,424,051	6,977,602	673,350	16,075,003
July...	7,298,618	4,903,789	412,721	12,615,128
Aug...	10,725,030	5,820,033	1,479,369	18,024,432
Sept...	6,872,398	4,365,135	343,270	11,580,803
Totals	61,946,311	39,905,563	4,085,255	105,937,129

New Excavating Record Made on Mine Stripping

During the month of July what is reputed to be a new world record for excavating on land was established by one of the outfits of A. Guthrie & Co., working on the Missabe Range in Minnesota stripping in the Hill Annex mines near Calumet. Working 57 ten-hour shifts in the month, the outfit loaded 244,710 cu.yd. into 30-yd. capacity cars, this being at the rate of 4,293 cu.yd. per shift. The shovel was mounted on railroad trucks, and had an 80-ft. boom, 52-ft. dipper handle, and an 8-cu.yd. dipper. The material handled was the heavy Missabe Range glacial drift.

Business Notes

THE AMERICAN PAULIN SYSTEM, INC., manufacturers of altimeters, has opened eastern offices at 1915 Land Title Building, Philadelphia, under the direction of H. L. Balderston, manager. Mr. Balderston was for 17 years secretary-treasurer of the Precision Thermometer & Instrument Co. of Philadelphia. A complete line of Paulin instruments will be carried in stock to assure best possible service to both dealers and customers.

TIMKEN ROLLER BEARING CO., of Canton, Ohio, and M. B. U. Dewar of London, England, together have purchased from Vickers, Ltd., all of the capital stock of British Timken, Ltd. This purchase gives Timken universal control of the manufacture and sale of Timken bearings. Mr. Dewar has assumed active management of British Timken affairs. Until recently he was managing director of the Metropolitan Carriage, Wagon & Finance Co. Ltd., of Birmingham, England. He is also a member of the Industrial Management Board of Vickers, Ltd.

INDIANA TRUCK CORPORATION, Marion, Ind., announces the appointment of Ray F. Townsend as assistant to the president, J. W. Stephenson. For the past several years Mr. Townsend has been connected with the Federal Motor Truck Co., of Detroit and prior to that time was with the Willys-Overland Co., of Toledo.

KURT C. BARTH, director of the research division, Western Red Cedar Association, died Oct. 9 at his home in Evanston, Ill., after a short illness. Mr. Barth organized the research division in the spring of 1925 and has been with that bureau since its inception. A large part of his business career was devoted to the study of wood preservation and wood strength problems.

New Developments

All-Steel, Four-Wheel Bottom-Dump Trailer

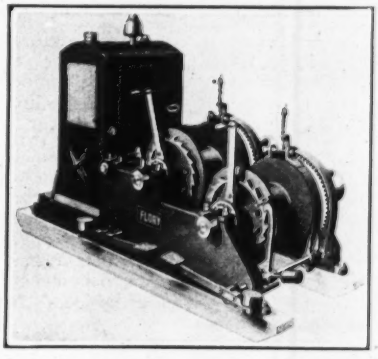
The Miami Trailer-Scraper Co., Troy, Ohio, has recently added to its line a 5-ton all-steel, 4-wheeled bottom-dump tractor trailer for use with heavy-duty tractors. Wheels are equipped with two Timken taper roller bearings providing against end thrust, both inward and outward. The fifth-wheel constriction is of the full cut under type and so designed that the front wheels will turn completely under the unit even with the bottom doors open, providing a short turning radius.

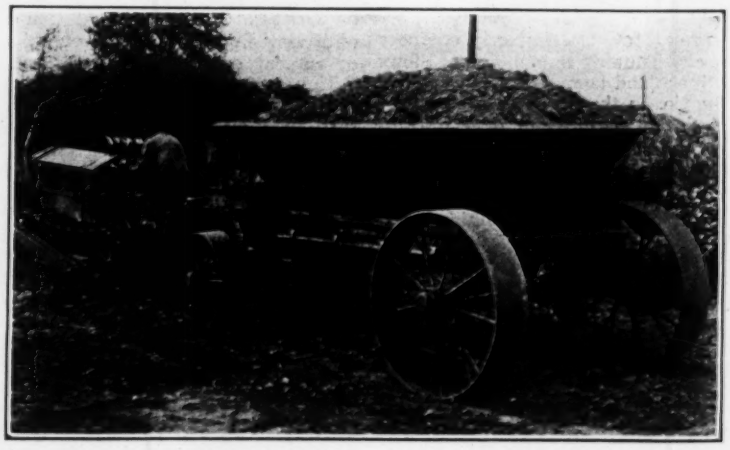
For train operation it is necessary to mount an extra hitch connector on the rear of each trailer. The trailer is only 64½ in. from the ground to top of body, making it easily adaptable to loading by power shovels, elevating loaders or hand shoveling. The body of the trailer has a water-level capacity of 3 yd., and will carry a full rounded load of from 4 to 4½ yd. This trailer is constructed so that the dumping device controls the opening of the bottom doors, enabling the operator to open the doors 6, 8, or 10 in. for spreading the load as the tractor moves forward. The entire load can also be dumped instantaneously.

The company also manufactures this same chassis constructed with a stake platform body for general hauling purposes.

Light Weight Gasoline Hoist Has Single Line Pull of 1500 Lb.

A new light weight and compact hoist has recently been designed by the S. Flory Mfg. Co., Bangor, Pa. It has a capacity of 1,500 lb. single line pull at a drum speed of 125 ft. per minute. Mounted upon its solid cast-iron base is a two-cylinder 8 to 10-hp. gasoline engine, which drives the drum gearing through sprockets and chain, the latter being inclosed in a sheet steel casing. All gears have machine cut teeth. The friction clutch is equipped





with molded asbestos cone, and the brake is of the two-piece band type lined with a non-burning material. The hoist is also equipped with a winch head and a ratchet and pawl. The complete outfit is mounted on skids. The hoist is made in single- and double-drum types, the single-drum outfit weighing 1,250 lb., and the double-drum outfit weighing 1,700 lb.

20-Ton Gas-Electric Locomotive

The first of its 20-ton double-truck series of gas-electric industrial locomotives was shipped recently by the Davenport Locomotive and Manufacturing Corp., Davenport, Iowa, to Winnipeg, Canada, where it will be

used by the city of Winnipeg's hydro-electric system. The new locomotive is similar in construction to the Davenport company's 25 and 30-ton models.

Equipment used in building this locomotive includes shutters on radiators for extreme weather conditions, snow plow, special arrangement of cab, with lighting, ventilating and hot-water heating systems, air sanders, straight and automatic air brakes, power take-off for direct current up to 240 v. for lighting, heating, cooking, operating electric motors, windlass pumps, etc. This locomotive has been built to maintain a schedule of 25 miles per hour over heavy grades and at temperatures varying from 47 deg. F. below zero to 110 deg. above.

Shears for Cutting Metal Lath

Specially designed shears to be used in cutting its No. 3 metal lath have been placed on the market by the Milwaukee Corrugating Co., Milwaukee, Wis. With these shears one man can cut the lath to any desired length without crushing or injuring the ribs. The blades of the shears are mounted on a 12x40-in. base made of cast iron, the entire machine weighing 400 lb. The blades of the shears are designed to fit the underside of the lath in a manner that supports the ribs so that they cannot be damaged while being cut. The blade is 27 in. long, the cutting surface being the same width as the lath. The shears may be rented or purchased.

Load Bearing Tile for Light-Occupancy Construction

Structolite tile, load bearing and incombustible, have been announced by the United States Gypsum Co., Chicago. These tile have hollow cores and are designed for erection of exterior walls and bearing partitions in light occupancy buildings. They are designed to withstand loads of 1,000 lb. per sq.in. gross area. Structolite tile are made with Structolite cement and can be obtained in standard 16-in. sizes of 4 sections: 8 x 8 in., 8 x 6 in., 8 x 12 in. and 6 x 12 in. None weighs more than 35 lb. per block.

Advantages claimed for the tile by the manufacturer are: The tile can be nailed, sawed and fitted with the ease of soft wood; they provide a true surface for exterior stucco; brick veneer easily is laid up over the tile; and with the tile reinforced, tile lintels are easily made on the job.

New Publications

Leaning Wheel Graders — GALION IRON WORKS & MFG. CO., Galion, Ohio, has issued a new bulletin describing its E-Z Lift leaning wheel graders. Various construction details of the machines are illustrated and described, and tables of dimensions and construction photographs are included.

Fans—JEFFREY MFG. CO., Columbus, Ohio, in its catalog No. 440, devotes 35 pp. to its "Safeload" fans for forced draft and high pressure duties. Besides illustrations and descriptions, over half the booklet is devoted to performance tables for different sizes of fans.

Lumber Data—WEST COAST LUMBERMEN'S ASSOCIATION, Seattle, Wash., has recently issued a number of new publications. Technical Bulletin No. 1 discusses the working stresses for standard grades of douglas fir. Technical Bulletin No. 2 is somewhat more comprehensive and considers the working stresses for structural grades of American lumber standards, including a number of useful tables. Technical Bulletin No. 3 is "Durability of West Coast Woods," No. 4 is "Creosote Treatment of Douglas Fir" and No. 5 is "Physical Properties of Woods." Another bulletin gives a comparison of physical and mechanical properties of douglas fir and Southern pine. The last bulletin entitled "The Mechanical Properties of Timbers," is written by C. J. Hogue, field manager of the West Coast Lumber Trade Extension Bureau. This bulletin discusses the fundamentals of design for timber construction.

Form Clamps—M & M WIRE CLAMP CO., Minneapolis, Minn., has published a 14-p. booklet illustrating its wire clamps, splicing clamps, adjustable shores, column clamps, targets for leveling concrete, screed gages, rod clamps, cutters and nippers.

Arc Welding Prize—LINCOLN ELECTRIC CO., Cleveland, Ohio, in conjunction with the American Society of Mechanical Engineers, has published a booklet giving the conditions governing the award of the Lincoln Arc Welding Prize. The booklet contains in addition to the official statement concerning the award, a number of suggestions by the Lincoln Electric Co. illustrative of the type of data to be submitted in the contest.

Pumping Handbook—NOVO ENGINE CO., Lansing, Mich., has published a 40-p. pumping handbook which contains much valuable information about pumps and pumping work. It is a companion booklet to the company's hoisting handbook. Other than the fact that the company's engines and pumps are shown in the many construction illustrations, the booklet is not concerned with the company's equipment. Some of the main heads under which infor-

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. Sixth Annual Show. New York City, Dec. 5-10.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

mation is given, are water handling in trench work, footings and excavations, weir tables, sand pumping, jetting work, oil field water supply, and road paving water supply.

Masons Cement—LOUISVILLE CEMENT Co., Louisville, Ky., has issued a booklet describing its "Brixment" masons cement which combines the characteristics of portland cement and lime. The booklet considers such factors with regard to Brixment as how to estimate, uniformity, strength, bond, moisture resistance, setting time, winter use and fast color.

Oil Tank Roof—CHICAGO BRIDGE AND IRON WORKS, Chicago, Ill., has just issued a booklet describing its new Wiggins breather roof for stopping evaporation losses from standing oil storage. Illustrations, and a complete description of the roof and the various accessories, such as valves, manhole covers, gage hatches, etc., are given.

Explosives — Commemorating its 125 years of existence, E. I. DU PONT DE NEMOURS & Co., has published a 48-p. booklet containing many items of general and special interest. The booklet traces the development of the original company into the present organization, which is engaged in such diverse fields. Of particular historical interest are notes upon black powder, the development of military powders and high explosives. Additional data are given on the present activities of the company in the fields of pyroxylin, plastics, paint, heavy chemicals, dyestuffs, textiles, and motion picture films.

Drills and Drilling — KEYSTONE DRILLER Co., Beaver Falls, Pa., has recently published two new catalogs. The first is the eighteenth edition of the general drill catalog, a book of 106 pages, describing drills for water well drilling, blast hole boring, mineral prospecting, placer gold testing and oil and gas well drilling. An interesting 4-p. history of well drilling is given at the first of the book. The second publication entitled "Keystone Blast Hole Drills" is a 60-p. catalog of specialized portable well drills, traction and non-traction, for use in cement and limestone quarries and in heavy excavation. A discussion of the best methods of spacing holes, loading and shooting is also included.

Field Design and Erection—KANSAS CITY STRUCTURAL STEEL Co., Kansas City, Kans., has published a 48-p. booklet telling the story of its service in the fabrication, design and erection of steel structures of all kinds. The booklet features many illustrations of outstanding structural jobs that the company has done covering such steel work as bridges, stacks, building frames, caisson cutting edges, storage bins, car dumpers, headframes and other mine structure installations, gfirain elevators, radio towers, high pressure oil stills, and oil storage tanks.

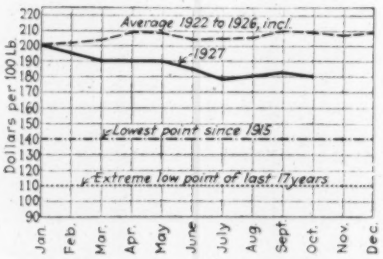
Business Side of Construction

Facts and Events That Affect Cost and Volume

Steel Prices Tend Downward

Current Level Midway Between October Average (1922-26) and Low Point Of Last Twelve Years

THE movement of structural steel prices, from month to month, since the beginning of the year, has been downward and away from, the monthly averages for the 1922-1926 heavy construction period, as shown in the accompanying diagram.



PRICE, STRUCTURAL SHAPES, BASE SIZES, IN ORDINARY TONNAGES F.O.B. PITTSBURGH

The present range of quotations, base, Pittsburgh, of $1.75 per 100 lb. on shapes in large quantities and $1.80 in single carlots, is just about midway between the average October price for the years 1922 to 1926, and the lowest quotation reached at any time since 1915. The current mill price on structurals, in several-carload lots, is 65c. per 100 lb. above the extreme low quotation of the last seventeen years.

Aside from the price element, the 1927 rate of ingot output and volume of unfilled orders at the end of each month have remained consistently below those of last year, since early in the summer.

With demand, production and prices tending downward (all seasonal influences considered) little hope is extended for higher steel costs during the remainder of the current year. At the same time, with general construction costs approximately 112 per cent above October, 1915, it is not to be expected that steel prices will approach much nearer to the level of $1.44 per 100 lb., which prevailed twelve years ago.

Imports of structural shapes and building forms of iron and steel, gained 58 per cent during the first six months this year, compared with last. This is another factor tending toward depression in price.

It is reported by the Department of Commerce, however, that bookings of fabricated structural steel by the principal manufacturers of the country, for the month of September, 1927, were 29 per cent heavier than for the same month last year. Improvement in purchasing was also evident during the week of Oct. 20, 1927, over demand of the preceding seven days.

Unit Prices From Construction News

Steel Electric Conduit In Place

The following are prices per lin.ft. included in the low bidders' estimates on various sections of New York subways, 1922 to 1926:

Date	¾-In.	1-In.	1¼-In.	2-In.	2½-In.
Nov., 1922	$0.30	$0.38	$0.50	.....	.....
Jan., 1924	.50	.50	.75	$0.95	.....
Oct., 1924	.40	.45	.55	.....	.....
Nov., 1925	.60	.70	1.00	.....	$3.00
Jan., 1926	.40	.50	.60	2.00	.....
Mar., 1926	.40	.60	.80	.....	3.00
July, 1926	.25	.50	.60	.75	.....
Aug., 1926	.50	.60	.70	.....	2.00
Sept., 1926	.....	1.00	.80	1.00	1.50

Waterproofing For Subways

These unit prices were included in the low bidders' estimates on various sections of New York subways from 1922 to date:

Date	Price per Sq. Yd. 1 Ply	2 Ply	3 Ply	4 Ply	5 Ply	6 Ply	Brick and Asphalt Mastic, per Cu. Yd
Nov., 1922	$0.80	.....	$1.55	.....	.....	$2.80	$38.50
Jan., 1923	.75	$1.25	2.00	$2.00	$2.50	3.00	42.00
Oct., 1924	.60	.....	2.50	3.50	.....	6.00	48.00
Feb., 1925	1.00	.....	3.00	3.50	.....	5.00	50.00
Sept., 1925	1.25	.....	2.50	.....	3.50	4.00	60.00
Nov., 1925	1.50	.....	2.50	.....	5.00	6.50	55.00
Jan., 1926	1.25	.....	3.00	.....	4.50	5.50	50.00
Mar., 1926	1.00	.....	3.00	4.00	.....	6.00	45.00
July, 1926	1.50	.....	3.00	.....	5.00	6.00	50.00
Sept., 1926	1.30	.....	3.00	4.00	5.00	6.00	45.00
Dec., 1926	.90	.....	2.50	.....	.....	5.00	44.00
Mar., 1927	.....	.....	2.50	.....	.....	.....	.....

Special Tabulation of Unit Bids

Cast-Iron Pipe

The following unit costs on standard sizes, bell and spigot type cast-iron pipe are included in low bidders' estimates on various projects, from 1922 to 1927:

Location	Date	Tons	Price per Ton
Sewage treatment works Marion, O.	Aug., 1922	110	$80.00
Water supply Tulsa, Okla.	Sept., 1922	24	90.00
Water supply Memphis, Tenn.	Oct., 1922	210	73.23
Sewerage system Dover, N. J.	Oct., 1922	32	90.00
Conduit Brooklyn, N. Y.	Dec., 1922	175	60.00
Sewers New Castle, Pa.	Mar., 1923	117	82.70
Circulation basin Cleveland, O.	May, 1923	108	80.00
Watermains Cleveland, O.	June, 1923	1,045	83.00
Service mains Cleveland, O.	July, 1923	2,390	83.00
Watermains Cleveland, O.	Aug., 1923	1,890	81.00
Tunnel Cleveland, O.	Nov., 1923	260	82.50
Watermains Cleveland, O.	Nov., 1923	930	78.00
Conduit New York, N. Y.	Jan., 1924	35	90.00
Brooklyn, N. Y.	Feb., 1924	140	100.00
Brooklyn, N. Y.	Jan., 1925	100	100.00
Subway, Sect. 34, R78 New York, N. Y.	Jan., 1925	175	120.00
Conduit Brooklyn, N. Y.	Feb., 1925	140	100.00
Subway, Sect. 1, R78 New York, N. Y.	Apr., 1925	350	100.00
Impounding reservoir Ashland, Pa.	Apr., 1925	62	100.00
Subway, Sect. 1, R5 New York, N. Y.	Sept., 1925	20	150.00
Subway, Sect. 4, R102 New York, N. Y.	Oct., 1925	300	125.00
Subway, Sect. 7, R78 New York, N. Y.	Nov., 1925	5	125.00
Subway, Sect. 3, R102 New York, N. Y.	Dec., 1925	250	130.00
Subway, Sect. 2, R102 New York, N. Y.	Dec., 1925	10	100.00
Viaduct Jersey City, N. J.	Mar., 1926	20	170.00
Subway, Sect. 5, R102 New York, N. Y.	Mar., 1926	150	120.00
Subway, Sect. 6F1, R8 New York, N. Y.	Aug., 1926	20	100.00
Subway, Sect. 1, R102 New York, N. Y.	Sept., 1926	15	100.00
Subway, Sect. 2, R104 New York, N. Y.	Oct., 1926	10	100.00
Subway, Sect. 3 & 4, R1 New York, N. Y.	Dec., 1926	255	100.00
Sewage treatment works New York, N. Y.	Jan., 1927	25	180.00
Sewage treatment works Chicago, Ill.	Jan., 1927	12½	180.00
Sewer Akron, O.	Mar. 1927	25	150.00
Sewage treatment works Chicago, Ill.	July, 1927	120	160.00

State and Municipal Bond Sales Light

September Disposals Smallest For That Month During Last Four Years

THE lead held by the 1927 contract total over that of a year ago, is due mainly to public lettings, according to *Engineering News-Record* statistics.

The decline of 23 per cent in September bond sales for state and municipal improvement, compared with the corresponding month last year, creates the impression that even the public work may yet go the way of privately-owned speculative building.

September bond disposals were the lightest in total money value, for that month, in any year since 1923.

Among the sales of the last month, aggregating $105,680,165, recorded by the *Commercial and Financial Chronical*, were the following major issues:

$19,040,000 bonds of the City of Detroit, Mich., consisting of six issues, awarded to the Bankers Trust Co. and the National City Co., as follows: $9,600,000 as 4's; $4,443,000 as 4½'s; $4,997,000 as 4¼'s. All sold at 100.03, a basis of about 4.12 per cent and mature serially from 1928 to 1957.

7,861,000 4 per cent St. Louis, Mo., bonds awarded to a syndicate headed by Estabrook & Co. of New York at 100.85, a basis of about 3.92 per cent.

6,000,000 bonds of the State of Alabama consisting of two issues which were awarded as follows: $5,000,000 coupon or registered road, highway and bridge bonds to a syndicate headed by the First National Bank, as 4¼'s, at 101.67, a basis of about 4.11 per cent. $1,000,000 coupon harbor improvement bonds to a syndicate headed by Lehman Bros. of New York, as 4½'s, at 101.71, a basis of about 4.16 per cent.

3,660,000 bonds of the City of Buffalo, N. Y., consisting of three issues of 4½ per cent obligations awarded to the Manufacturers & Traders-Peoples Trust Co., of Buffalo, at 102.71, a 3.87 per cent basis.

3,360,000 bonds of Milwaukee, Wis., consisting of seven issues of 4½'s, awarded to the First National bank, at 104.10.

2,650,000 4 per cent bonds of the State State of Rhode Island, consisting of four issues awarded to a syndicate composed of the First National Bank, Phelps, Fenn & Co., Eldredge & Co., and Kean, Taylor & Co., all of New York, and the Industrial Trust Co. of Providence.

2,450,000 Memphis, Tenn., bonds awarded to a syndicate headed by the Guaranty Co. of New York, taking $1,700,000 4½ per cent various improvement bonds on a 4.26 per cent basis, and $750,000 4½ per cent school bonds at 103.32, a basis of about 4.285 per cent.

2,250,000 4 per cent refunding war loan bonds of the State of Michigan, awarded to Eldredge & Co. of New York City.

2,000,000 bonds of the State of West Virginia, consisting of three issues awarded to a syndicate headed by Eldredge & Co. and R. H. Moulton & Co., at par, taking $1,620,000 bonds as 4½'s, and $380,000 bonds as 4½'s.

$ 1,650,000 highway bonds of Oklahoma County, Okla., awarded to the Taylor-White Co., and the Fidelity National Bank, both of Oklahoma City, taking $1,430,000 bonds as 4½'s, and $220,000 bonds as 4's.

1,500,000 4½ per cent bonds of Davidson County, Tenn., awarded to a syndicate headed by E. H. Rollins & Sons, at 103.11, a basis of about 4.25 per cent.

1,375,000 bonds of Raleigh, N. C., consisting of four issues awarded to a syndicate headed by Ames, Emerich & Co., as 4½'s, at 102.17, a 4.28 per cent basis.

1,300,000 4½ per cent Roanoke, Va., bonds consisting of four issues awarded to a syndicate headed by Pulleyn & Co., at 103.20, a basis of about 4.27 per cent.

1,251,000 bonds of the City of Toledo, Ohio, consisting of ten issues, awarded to Stranahan, Harris & Oatis, Inc., of Toledo, at 102.91, a basis of about 4.12 per cent taking $1,143,000 bonds as 4½'s, and $108,000 bonds as 4's.

1,233,000 Omaha, Neb., bonds consisting of three issues awarded to Eldredge & Co. of New York, at 100.22, a basis of about 4.10 per cent, taking $661,000 bonds as 4½'s, and $572,000 bonds as 4's.

1,200,000 Cheetowaga, N. Y., sewer bonds awarded to a syndicate headed by George B. Gibbons & Co. of New York, as 4.40's, at 100.88, a basis of about 4.32 per cent.

1,100,000 4½ per cent Caddo Parish, Louisiana, improvement bonds awarded to the City Savings Bank & Trust Co., of Shreveport.

1,000,000 4½ per cent Lincoln Park District, Chicago, bonds awarded to a syndicate headed by A. B. Leach & Co. of New York, at 103.90, a basis of about 4.03 per cent.

1,000,000 Louisville, Ky., school building bonds awarded to a syndicate headed by Henning, Chambers & Co. of Louisville, as 4's, at 102.66, a basis of about 3.85 per cent.

1,000,000 Multnomah County, S. D. No. 1, Ore., bonds awarded to a syndicate headed by the Security Co. of Los Angeles, as 4's, and 4½'s, at 103.76, a basis of 4.19 per cent.

1,000,000 4 per cent Portland, Ore., water bonds awarded to a syndicate headed by Halsey, Stuart & Co. at 98.46, a basis of about 4.13 per cent.

Costs Per Lin. Ft., Etc.

Sewers in Louisville, Ky., 5½x5½ ft. semi-eliptical reinforced-concrete, in open ditch, with junction chambers and manholes, @ $33.86 per lin.ft.

Sewers in Mt. Clemons, Mich., 1 mi. monolithic concrete double box section, 6½x8 ft., @ $40.85; 8,000 ft. 8 ft. 10 in. x 8 ft., @ $33.77 per lin.ft.

Steel sheetpiling in Cattaraugus Co., N. Y., 4,500 sq.ft. @ 38c. per sq.ft.

Power tunnel at Bridge River, British Columbia, 13x13 ft. x 2½ mi., about two-thirds lined with concrete, low bid $947 per lin.ft. Engineer's estimate, $2,000,000 or $152 per ft. Estimated time to complete, 1,000 days.

Gas holder, 68 ft. diameter x 70 ft. high, in Belleville, Ont., estimated $50,000.

Unit bids on hospital for U. S. Veterans Bureau, at Tucson, Ariz., as follows:

	Value	Per Cent of Total
General contract	$787,134	71.8
Electrical work	56,610	5.2
Plumbing and heating	224,000	20.4
Refrigeration	23,496	2.2
Concrete chimney	4,490	.4
Total	$1,095,730	100.0

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
October 27, 1927...	$22,378,000	$55,194,000	$77,436,000
October 20, 1927...	40,273,000	18,870,000	59,143,000
October 28, 1926...	25,519,000	41,341,000	66,860,000
Jan. 1 to date			
1927	1,082,343,000	1,538,555,000	2,620,898,000
1926	936,210,000	1,481,213,000	2,415,362,000

E.N.-R. Index Numbers

On October 1, 1927

COST	VOLUME
204.40	273
Last Year 209.80	Last Year 227

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb....	$3.34	$3.75	$4.00	$3.10	$3.35	$3.87½	$3.00	$3.00	$4.00
Structural rivets, per 100 lb....	5.00	4.00	4.75	3.60	3.85	4.64	5.50	5.25	5.50
Reinforcing bars, per 100 lb....	3.24	2.99	2.75	2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	—40.60	—34.50	—52.00	—36.20	—40.50	—52.00	—39.00	—53.00	—39.00
Concreting Material									
Cement, without bags, per bbl. .	2.35†	2.40	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.....	1.75	2.20*	2.38	2.00	1.25*	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd...	1.85	2.50*	2.83	2.00	1.25*	2.50	1.70	2.50	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.50(S&S)	36.75@ 38.75	34.25	27.00	24.00	55.00†
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.....	65.00@62.00†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton...	19.45	24.50	19.00	20.00†	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl ..	2.35@2.50‡	1.35	1.82	1.50†	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@18.00†	12.50	13.60	12.00†	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724†	.103	.....	.072	.085	..	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724†	.103	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	—.78¾	87	.85	.79	87	—.88	—.84	.98	—.93
Common Labor									
Common labor, union, per hour.	.90⅝	.30	.....	.90	.....	.....	.62½	.70	.....
Common labor, non-union, hour.	.....	.25	30@.50	.82½	.45@.60	.31¼@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

THE present level of building materials prices, for the entire country, is not more than 3½ per cent below that of a year ago. Much of the downward pressure in the current market is due to seasonal influences, since figures at the top of this page show 1927 well in advance of last year, as far as money expended for construction is concerned.

Average prices of twenty basic materials in fifty-four cities, secured by the Department of Commerce through the Census Bureau are as follows:

Brick, common, per M., $16.83; compared to $16, the minimum price, delivered, at New York.

Cement, portland, exclusive of cost of bags, per bbl., $2.87; present price at New York is $2.35 per bbl., delivered, deducting charge for bags.

Boards, No. 1 common, 1x6-in., per M. ft., $42.59.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Oct. 6, the next on Nov. 3. Explanation of prices contained in the table will appear from time to time in this section; last shown Aug. 11, 1927, p. 247.

Shingles, red cedar, extra clear, 16-in., 5 to 2, per 100 sq.ft., $6.26.

Shingles, composition, crushed slate surfaced, per 100 sq.ft., $6.81.

Lime, hydrated, common, per ton, $20.23.

Aggregates — Building sand, per cu.yd., $2.05; crushed stone, ¾ in., per ton, $2.68.

Wire nails, per keg, $3.78.

Window glass, Single A, 10x12-in., per 50 sq.ft., $4.32.

Hollow tile, 8x12x12-in., per block, $0.199.

Cast-iron soil pipe, 4-in., 13 lb. per ft., per net ton, $76.51.

Steel pipe, 1-in., galvanized, per 100 ft., $11.18.

Steel reinforcing bars, ¾-in., square, per 100 lb., $3.46.

Fabricated steel structurals, 6-in., I beams, per 100 lb., $4.10.

Paint materials—White lead, dry, per 100 lb., $13.99; zinc oxide, lead free, American process, per 100 lb., $15.41; linseed oil, raw, in barrels, per gal. (7½ lb.), $1.01.

Gypsum plaster, neat, per ton, $17.98.

Roofing slate, No. 1, ribbons, per 100 sq.ft., $14.20.